FOOD TECHNOLOGY

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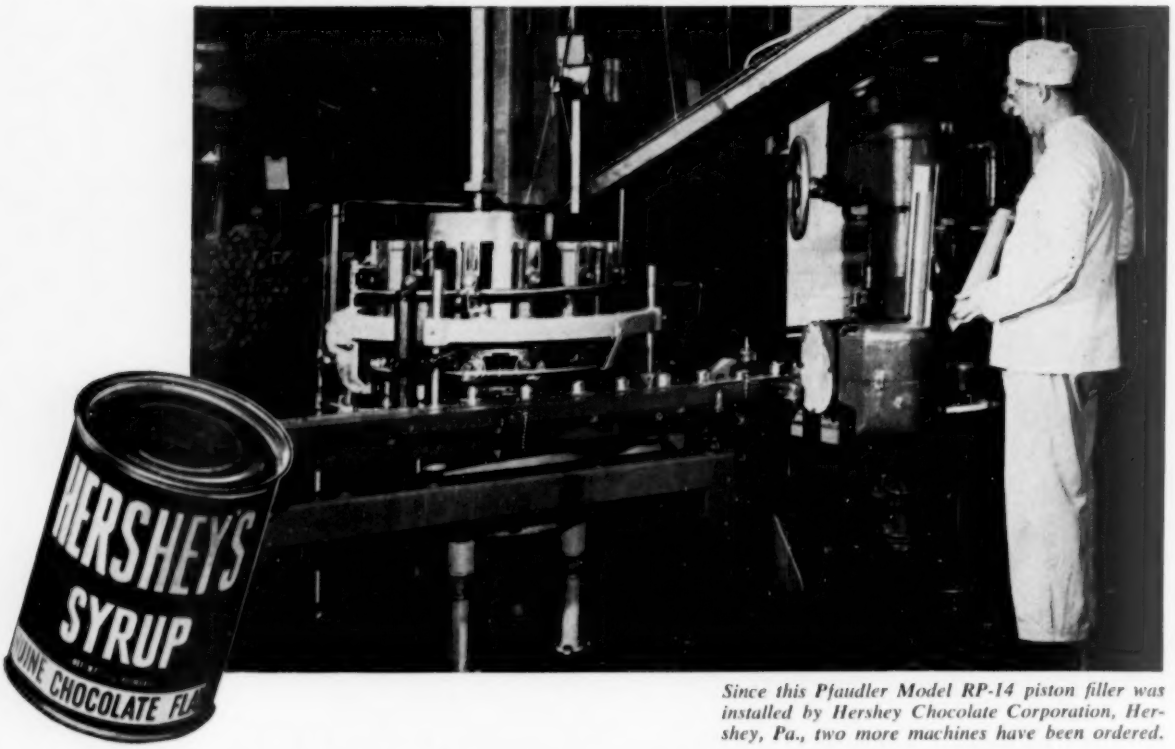

Since this Pfaudler Model RP-14 piston filler was installed by Hershey Chocolate Corporation, Hershey, Pa., two more machines have been ordered.

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Control on these fillers is so precise that even at high speeds, filling is accurate to ±1/10 of an ounce on most products. Adjustments can be made while machine is operating. There is no slop-over or waste.

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Jury Gives 1954-Babcock-Hart Award to Edwin John Cameron
Recently Elected Members of IFT
Charles N. Frey Announced as Nicholas Appert Award Winner
Regional News
Books
Selected Abstracts
Food Industry Topics
Meetings

Jury Gives 1954 Babcock-Hart Award to Edwin John Cameron

The Babcock-Hart jury of the Institute of Food Technologists has cited Edwin John Cameron, Director of the Washington Research Laboratories of the National Canners' Association to receive the 1954 award. This distinguished award—made possible by a grant provided by the Nutrition Foundation, Inc.—will be presented to Dr. Cameron at a luncheon meeting on June 29 during the Annual Meeting of the Institute at the Biltmore Hotel, Los Angeles, California. Established in 1948 to honor Stephen M. Babcock, the award was expanded in 1954 to jointly honor Edwin Bret Hart, a lifelong colleague of Dr. Babcock. The grant which carries an award of One Thousand Dollars is given to a recipient who has advanced human nutrition by outstanding achievements in the fields of food research or technology. The winner of the award is selected by a jury of nine, named by the Council of the Institute, with the president of the Institute as its chairman, but without vote.

Born in Cambridge, Mass., Dr. Cameron received his early education in the schools of Massachusetts, and in 1920 received his Bachelor of Science degree from the Massachusetts Institute of Technology. His college work was interrupted by two years of service during World War I in the Medical Corps of the A. E. F. His major at M. I. T. was Biology, Public Health, and Industrial Option, a choice which foreshadowed his subsequent career. He received his doctorate from George Washington University in 1927, his dissertation being based on original field studies undertaken to advance the bacteriology of canning.

Dr. Cameron began his industrial experience as a bacteriologist in the commercial production of industrial solvents. His three years of service sharpened his perception of microbiological problems, and stood him in good stead later when he attacked analogous problems in food canning.

Dr. Cameron joined the staff of the National Canners' Association Research Laboratories in 1923 and in 1927 was placed in charge of bacteriological work in the Washington Laboratory. In 1936 he was appointed Assistant Director of the Washington Laboratory, and since 1939 has been Director.

For over 30 years, Dr. Cameron has been identified with canning research and technology. His direct contributions have been numerous, and he has given stimulus to many others. The bacteriological surveys in canning factories which he inaugurated have pointed the way to removing the sources of spoilage contamination and have also led to bacterial standards for canning ingredients—vital in the prevention of spoilage.

Although working in a well-defined area, Dr. Cameron has never been content to be a narrow specialist but has assumed the obligations of a good citizen of the professional and scientific worlds in which

Dr. Edwin John Cameron

his talents were developed. He has served for several years as advisory editor of the *Journal of Bacteriology*, an an associate editor of Food Research, as an Associate Referee of the Association of Official Agricultural Chemists, as a charter member of IFT, and for a number of years as a member of the Industry Advisory Committee of the Nutrition Foundation, Inc.

In 1941 Dr. Cameron turned his energies increasingly into research on the nutritive qualities of canned foods. When the National Nutrition Conference for Defense of 1941 indicated the need for improving nutritional knowledge in all fields, Dr. Cameron undertook a program on behalf of the canning industry to fulfill that need.. He convinced food industry leaders that nutrition projects placed under grants-in-aid at universities recognized as leaders in the field would be productive. This program, coordinated by a committee under Dr. Cameron's chairmanship, yielded notable results, as over 50 publications, including journal papers, bulletins, and a reference book, "Canned Foods in Human Nutrition," will attest. Through active participation in Government research programs and the National Research Council he has also contributed materially to the technology of food standards for both military and civilan use.

Dr. Cameron has a host of friends in the canning industry, people who have gained from his endeavors and

(Continued on page 8)

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The Vital Story of MACARONI* ENRICHMENT

by Science Writer

This is the fourth article in a series devoted to the story of cereal enrichment

Dramatic results have been recorded about the value of enrichment in improving health. From the United States, the Bataan peninsula in the Philippines, Newfoundland and many other parts of the world comes word of the great benefits which result from enrichment.

For years, some forward-looking manufacturers of macaroni and noodle products have used enrichment to make their good foods better. They know that enrichment restores important vitamin and mineral values which are unavoidably lost in milling, and they recognize their responsibility to provide the greatest health-building benefits for the public.

Enrichment is really a simple process. It adds the following essential elements to the food during manufacture.

Thiamine—also called vitamin B_1. This vitamin helps to build physical and mental health. It is essential for normal appetite, intestinal activity and sound nerves.

Riboflavin—also called vitamin B_2. This vitamin helps to keep body tissues healthy and to maintain proper function of the eyes. It is essential for growth.

Niacin—another "B" vitamin, is needed for healthy body tissues. Its use in the American diet has done much to make a serious disease called pellagra disappear.

Iron—is a mineral used in all enrichment. It is essential for making good, red blood and preventing nutritional anemia.

Products made from semolina may be enriched by two methods. One uses small square wafers which contain all the vitamins and iron necessary to enrich 100 lbs. The wafers break up in a small amount of water which is then added to the paste. For manufacturers who use the continuous press method, a powdered concentrate of the vitamins and iron, called a premix, is available. This is added by a mechanical feeding device.

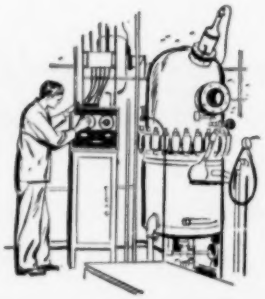
*Macaroni is used here in the generic sense. It includes all alimentary pastes: macaroni, spaghetti, pastina, noodles.

These are the minimum and maximum levels, in milligrams per pound, required by the Federal Definitions and Standards of Identity for enriched alimentary pastes.

	Min.	*Max.*
Thiamine (vitamin B_1)	4.0	5.0
Riboflavin (vitamin B_2)	1.7	2.2
Niacin	27.0	34.0
Iron	13.0	16.5

NOTE: These levels allow for 30% to 50% losses in kitchen procedures.

Nowadays scientists are able to "build" duplicates of many of Nature's essential complexes in the laboratory. This has happened with many vitamins. First the chemical composition is learned and the pure substance is isolated. Then a "duplicate" is made which is identical chemically and biologically with Nature's product. A vitamin is a vitamin regardless of its source just as salt is salt whether it comes from a mine or is evaporated from the sea. So efficient is large scale manufacturing that vitamins are sold at a lower cost than if they were extracted from natural sources.



The Hoffmann-La Roche people, who produce a good percent of the vitamins used in enrichment, use amazingly complex processes with scientific production controls. This requires modern, special equipment filling whole buildings, each one a city block square and many stories high.

The combination of scientific research, thorough know-how and mammoth manufacturing processes—plus the far-sightedness of leaders in the macaroni industry—is helping vitally to make good macaroni products better.

This article, reprints of which are available without charge, is published as a service to the macaroni industry by the Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West, Montreal, Quebec.

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JURY GIVES 1954 BABCOCK-HART AWARD TO EDWIN JOHN CAMERON

(Continued from page 2)

recognize his part in making their operations more rational and successful. If a single quality were to be selected as a key to his career, it might well be loyalty. He is loyal to his employers, loyal to his associates, and loyal to his profession. This he shows to his employers by continuing constructive achievement; to his associates by encouragement of their efforts and ambitions, and optimism toward their success; to his profession by willingness to undertake tasks beyond his daily responsibilities. In honoring him with the Babcock-Hart Award, the Institute pays tribute not alone to his achievements but also to the qualities and standards that have made them possible.

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Notes from the makers of
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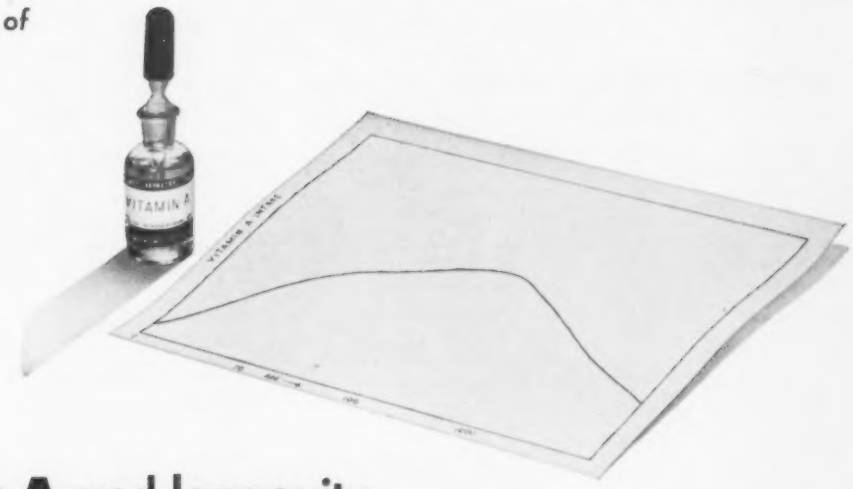

Vitamin A and longevity

There *is* correlation between longevity and vitamin A intake—at least a correlation that is statistically significant with rats.

With no vitamin A whatever there is trouble. If this were not so, vitamin A would never have been discovered in the first place. At a level of 0.8 U.S.P. units of vitamin A per Calorie of food intake, a rat grows fairly well and shows no signs of xerophthalmia. In fact, one laboratory rat family was reported thriving in the 67th generation at this level, but doubling this level seems to do something for the individual rat, if not for the race. In males it increases the span of life about 5 per cent and in females about 10 per cent.

A second doubling stretches the life span another 10 and 12 per cent, respectively, and, what's more, in some ways it's a better life. The reproductive life of the female rats is extended more, proportionally, than the length of life itself.

But, alas, the conclusion that vitamin A must be the elixir sought by the alchemists is unjustified. A maximum in the curve there must be, but it is still a little vague.

Such scientific work we point out for its possible interest to users of vitamin A in the pharmaceutical and food industries. For ourselves, we like to know all we can about vitamin A so we can help you with any problem you may have in the formulation and utilization of vitamin A in your products.

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216 Delaware Ave.
Ithaca, N. Y.

Raoul A. Cowley
Rockledge
Ithaca, N. Y.

Leonidas J. Kallerges
17 South Ave.
Ithaca, N. Y.

Richard H. Kennedy
125 Highland Place
Ithaca, N. Y.

Lawrence M. Lewin
105 DeWitt Place
Ithaca, N. Y.

Richard I. Mateles
3 Ames St
Cambridge, Mass.

Robert G. Pippitt
711 W. Illinois
Urbana, Ill.

Joseph D. Shore
202 College Ave.
Ithaca, N. Y.

Leonard Solomon
216 Cascadilla Park
Ithaca, N. Y.

Joseph Tobin
1735 Kline Rd.
Ithaca, N. Y.

George R. Wilkens
17 South Ave.
Ithaca, N. Y.

Demetrios A. Zampelas
210 Dryden Rd.
Ithaca, N. Y

Dulal C. Basak
c/o Professor Reuter
N. S. W. Univ. of Tech.
Hostel
High Street, Kensington,
Sydney, N. S. W. Australia

Minoo C. Reporter
Allen Place
Boston 14, Mass.

Regional Section News

CHICAGO SECTION

Dr. C. G. King, Scientific Director, Nutrition Foundation, New York City presented a talk on the relationships existing between food and obesity before the Chicago section on March 8. Elements of good nutrition as well as harmful nutritive effects resulting from incomplete diets were discussed. The goal of the Nutrition Foundation, according to Dr. King, is the "well nourished individual" which can be achieved only through an adequate supply of good food, education, and research.

H. E. Robinson, Assistant Laboratory Director, Swift & Co. introduced Dr. King to an overflow crowd. Numerous questions were asked by those assembled after the talk—a tribute to a stimulating and informative presentation.

Plans for future meetings were announced by program chairman John Jackson:

April 19th (Monday)—H. C. Diehl of Refrigeration Foundation and past president of IFT.

May 13th (Thursday)—Milwaukee meeting at Millers Inn.

Charles N. Frey, retired Director of Scientific Relations for Fleischmann Laboratories, New York, has been named the 1954 winner of the Nicholas Appert medal by the Chicago Section of the Institute of Food Technologists. A sketch on the medalist will appear in the June issue. The award will be made at the convention in Los Angeles.

VANCOUVER SECTION

A dinner meeting of the B. C. Section of the Institute of Food Technologists was held Tuesday, February 23 at the Alcazar Hotel, Vancouver. The guest of honour and principal speaker was Dr. W. V. Cruess, Professor of Food Technology at the University of California at Berkeley. Other guests were Norman Barkwell, President of the B. C. Canned Foods Association; M. J. Olds

(Continued on page 12)

FINE FOODS

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REGIONAL SECTION NEWS

(Continued from page 10)

and G. L. Anglin, Anchor Hocking Glass Co., Seattle; and Frank C. Lamb, Head Chemist, National Canners Association, Berkeley, California.

Out-of-town members present were F. E. Atkinson, C. C. Strachan, John Ruck and A. J. Crawford from the Summerland Experiment Station, Ian Greenwood, B. C. Fruit Processors, Kelowna, and Mr. and Mrs. Ivan Brown, Growers Wine Company, Victoria. We enjoyed meeting these out-of-town members who are unable to meet with us regularly.

Three new members were introduced by Chairman Pete Sunderland. They were W. Norman Ritz, Continental Can Co., Burnaby (recently transferred from Toronto), John Walters, Canada Dry Co. Limited, and Rosalie Triggs, B. C. Coast Vegetable Marketing Board. The large attendance of local members made this one of the largest meetings of the year.

After an excellent turkey dinner (with sherry!), F. E. (Ted) Atkinson introduced Dr. Cruess, who spoke on "Flor Yeasts and Flor Sherries." Mr. Atkinson pointed out that Dr. Cruess is one of the pioneer food technologists. He is a past President of IFT, the winner of an Appert Award, and a Medal from the French Government, to name only a few of his accomplishments.

Dr. Cruess outlined the history of wine making in California since 1790 . During the years of prohibition, the acreage of grapes increased! Families were allowed to make 200 gallons of wine per year for their personal use and therefore the market for fresh grapes flourished. After repeal in 1933, the wine industry slowly re-established itself, and today manufactures almost all types of wine.

Manufacture of true Spanish Cherries depends on the use of Flor Yeasts. These yeasts form a floating film of yeast in the aging casks or "Solera." As these Flor Sherries were felt to be more desirable than the "baked" Sherries, Dr. Creuss set out to obtain a suitable strain of Flor Yeasts. Cultures were obtained from Germany, South Africa, India and many other countries. Laboratory work yielded about 25 pure strains that appeared promising. Further pilot plant studies lead to the selection of the best strain, and it is now being used in commercial sherry production in California.

Samples of Flor and Baked Sherries were tasted by the group. After answering many questions, Dr. Cruess was thanked for his interesting talk by Dr. C. C. Strachan.

ST. LOUIS SECTION

For the March meeting, the St. Louis section convened on the campus of the University of Missouri, at Columbia, for a two-day session on March 19 and 20. About fifty-five people were in attendance. A program was presented as a cooperative project of the staff of the Agricultural College and section IFT members.

The meeting this year took on added significance. The University, recognizing the growing importance and common interests with us in the field of food technology, gave their added support by including this meeting in their "short course" program, listing it as a short course in Food Technology. The section wishes to thank the University for their recognition as well as for making available to us ample facilities for the meeting.

In addition to the three symposia on special dietetic foods, microbiological problems in food production, and flavor and odor evaluation, the program also included a tour of the campus facilities relating to food technology and a dinner meeting talk on radiation sterilization. We were particularly fortunate in having as our guest, Dr. Clifcorn, Director of Fundamental Research, Continental Can Company, who not only served so ably as Chairman of the Symposium on Dietetic Foods, but presented as well a most enlightening dinner talk on the subject of "Radiation Sterilization — What is Its Future?"

Each and every person in attendance is looking forward enthusiastically to next year's short course.

Our May dinner meeting is scheduled for May 20 at the Forest Park Hotel. The speaker for the evening is to be Mr. J. W. Ranftl, of the Industrial Products Division, G. E. Company, Inc., X-Ray Department. His subject will be "Overall Use of Electronic Equipment in Food Processing."

DIXIE SECTION

On Friday, March 26, at Emory University, the following program of papers was presented before the Section:

Factors Affecting Gelation of Frozen Egg Yolks—Anthony Lopez, Department of Food Technology, University of Georgia, Athens.

Germination of Spores in Meats During Cure—J. Orvin Mundt, C. J. Mayhew, and Gwendolyn Stewart, Department of Bacteriology, University of Tennessee, Knoxville.

Examples in Multiple Regression—Don Holmes, Engineering Experiment Station, Georgia Institute of Technology, Atlanta.

Problems in the Processing of Chinese Chestnuts—Hubert Harris, Department of Horticulture, Alabama Polytechnic Institute, Auburn.

Refrigerated Storage of Pecans—E. K. Heaton, Georgia Experiment Station, Experiment.

Refrigeration Retained Quality in Peanut Candy—Barbara Grant Cowan, Georgia Experiment Station, Experiment.

A Rapid Method for Testing Stability of Potato Chips—Erika Nakamura and Barney Hilton, H. W. Lay & Co., Atlanta.

Design of Experiments—Joe Moder, Engineering Experiment Station, Georgia Institute of Technology, Atlanta.

The Response Rating System of Taste Testing and Experiments Using This Design—Barney Hilton, H. W. Lay & Co., Atlanta.

In addition to the speakers listed, John J. Powers and Dan Pratt, Department of Food Technology, University of Georgia, Athens, also presented a report. Dinner speakers were Mr. J. J. McManus, retired chief of the

(Continued on page 14)

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REGIONAL SECTION NEWS

(Continued from page 12)

U. S. Food and Drug Administration for this area and Dr. J. A. Woodroof who commented on the papers.

GREAT LAKES SECTION

The Section's April Meeting was held on the 9th at the Hart Hotel in Battle Creek, Mich. In the morning plant tours were arranged at the Michigan Carton Co., Post Cereal Plant and the Kellogg Co. Following is the technical program held during the afternoon:

Report on 1953 Conference of Cook Book and Recipe Writers —Mrs. Regina Frisbie, Director, Home Economics Department, Kellogg Co.

Bacteriological and Public Health Aspects of Sanitation—Dr. W. L. Mallmann, Michigan State College.

Chemicals and Cleaning Materials for Food Sanitation—Mr. Clark Moore, Cowles Chemical Co.

Coffee Period, 3:30 P.M.—Courtesy Kellogg Co.

A Practical Sanitation Program—Mr. R. A. Telder, Michigan State College.

The dinner speaker was Mr. Roger Pryor, Foote Cone & Belding Advertising Agency, and his subject was "Future Developments in Television."

AUSTRALIA NORTHERN SECTION

The Section met jointly with the Australian Institute of Refrigeration on March 8, 1954 at C. S. I. R. O., Homebush. Speakers were E. W. Hicks ("Railway Refrigeration") and O. P. Barr ("Road Transport Refrigeration"). A combined meeting was also planned for April with the Dietetians' Association of Australia (date not set at time of writing). The 1954 annual convention will be held May 26-29 at The Ritz, Leura. At time of writing, the following technical sessions appear to be reasonably definite:

Symposium on Quality Control: Chairman—H. S. Jessep.

"Application of Statistical Quality Control to the Food Industry"—J. Hely, Lever Brothers Pty. Ltd.

"Quality Control of Cereal Foods"—M. Bishop, William Arnott Pty. Ltd.

"Quality Control of Specialized Foods"—C. M. Martin, Cottee's Passiona Ltd.

"Quality Control in the Cannery"—F. Seale, C. O. D. Cannery, Brisbane.

"Organisation of Quality Control"—C. Dawson, Holbrooks' (A'sia) Ltd.

Session to be followed by "Panel of Experts" question session.

General Session: Chairman—F. R. Reuter.

"Heat Transfer"—G. Roper, N. S. W. University of Technology.

"Colloidal Aspects of Food"—A. E. Alexander, N. S. W. University of Technology.

"Treatment of Boiler Waters"—Hall, N. S. W. Railways.

"Bulk Handling of Sugar"—Devin, C. S. R. Ltd.

Symposium on Packaging: Chairman—F. C. Elsworth.

"Some Properties of Paper and Board"—G. Redding, Australian Paper Manufacturers Ltd.

"Some Properties of Glass"—Speaker from Australian Glass Manufacturers Ltd.

"Flexible Packages"—A. T. Roche, W. H Brookhouse Pty. Ltd.

"Adhesives for the Food Industry"—J. E. Rice, Dewey & Almy Ltd.

"Prediction of Shelf-life of Packaged Foods"—E. W. Hicks, C. S. I. R. O.

Session to be followed by "Panel of Experts" question session.

NEW YORK SECTION

The February meeting was held at the Brass Rail Restaurant, 43rd & 5th Avenue, New York, on February 17th. One hundred and fifty members and guests heard Dr. Emil Mrak talk about work in progress in the Food Technology Laboratories of the University of California. Dr. Mrak presented a professional subject in a professional manner and lived up to his well deserved reputation for being one of the IFT's best expositors of interesting material. He is on Sabbatical leave and has been spending much of it at M. I. T. accompanied by Mrs. Mrak.

The work described included basic and important phases of Food Technology. The fundamental relationships between canned fruit quality and the factors of plant nutrition, insecticide and hormone treatment and processing practices were discussed. Specific examples were given of definite relationships between subjective quality determinations by organoleptic scoring and objective tests of physical and chemical characteristics. Dr. Mrak covered improvements in processing and handling dried fruits which obtain greater acceptance of the products of the oldest method of fruit preservation. By increasing the moisture content in dried figs from 21-22% to 28%, a greater consumer acceptance has been gained but concurrent technological problems have appeared, one of which is the development of sugar crystals on the dried fruit when shipped to colder climates. Also, there are problems of growth of sugar-tolerant yeasts and molds in the more moist fruits. Their growth can be controlled by a low temperature thermal process followed by quick cooling to prevent the browning reaction, but ethylene oxide to the amount of 0.3 cc. in a sealed case of the dried fruits will accomplish the same result. The current trend is also toward higher moisture content in prunes (30-32% H_2O) and dates (30% H_2O) both of which present similar spoilage problems that can be controlled by either heat treatment or Ethylene Oxide.

The details of the sex life of the fig were shown to be not only interesting *per se*, but economically important as well, for it is the wasps that carry pollen to the female fruit that also carry yeast and mold spores. An excellent one-reel sound movie was shown describing work being done on canned peaches at the experimental station at Davis, California.

OHIO VALLEY SECTION

Battelle Memorial Institute in Columbus was host to the Section on Saturday, February 20. Dr. K. Starr Chester of Battelle served as chairman of local arrangements and extended warm hospitality to the group. Colonel Charles S. Lawrence, Executive Scretary of the Institute of Food Technologists, extended greetings from the national office.

(Continued on page 16)

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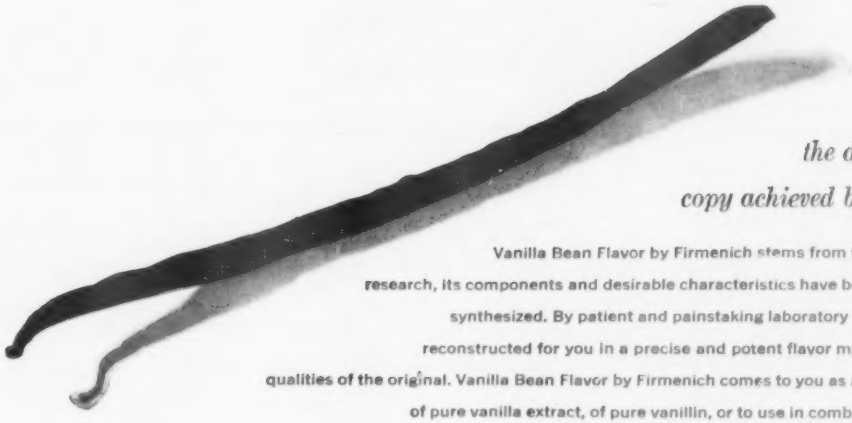

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REGIONAL SECTION NEWS

(Continued from page 14)

The technical session was opened at 10:15 A.M. with Dr. A. R. Winter presiding. These subjects were presented:

"Some Observations on the Relation of Muscle Biochemistry to Meat Quality"—Dr. F. E. Deatherage, Department of Agricultural Biochemistry—The Ohio State University.

"The Role of Phosphates as Food Additives"—Dr. Robert P. Joslin, Monsanto Chemical Company.

Luncheon was served at noon to sixty-five members and guests in the Battelle dining room. The afternoon program, at which Dr. George F. Garnatz presided, was opened by announcements concerning the 1955 Convention plans. Dr. H. D. Brown introduced the chairmen of subcommittees and discussed the work of each subcommittee. The technical session was continued with the presentation of the following topics:

"Food for the Future," Dr. K. Starr Chester, Battelle Memorial Institute.

"Advances in Dairy Technology," Dr. O. F. Garrett, M and R Dietetic Laboratories.

"Food Plant Wastes, the Unique Universal Problem," Mr. Jack C. Leonard, Commonwealth Engineering Company of Ohio.

After a short business meeting, the Program Chairman, Dr. Garnatz, announced that the Spring meeting will be held jointly with the Indiana Section on Saturday, April 10, in Indianapolis with the Indiana Section as host.

PHILADELPHIA SECTION

The Section met March 2, 1954, at Drexel Institute. Mr. Pratt reported on his visit to the Southern California Section, and to the Carnation Milk Company plant and the Scripps Metabolic Institute.

A motion picture entitled "The Mark of C" was shown, which portrayed, in entertaining and dramatic fashion, the important part played by bread in the history of our nation from Colonial times down to the present.

Dr. Kohman introduced the speaker, Carlos A. Greenleaf, Assistant Director of the Washington Laboratories of the National Canners Association, who spoke on the subject, "Fluoridation of Water Supplies and What it Means to the Food Technologist." The history of events leading to the fluoridation of water supplies was discussed, including the experiments carried out by the U. S. Public Health Service at Newburgh and Kingston, New York, during the years 1945 to 1951. The statistical results of these experiments were shown in graphical form. The arguments against fluoridation were presented and evaluated.

The effects of using fluoridated water in food processing industries were discussed. Types of processed foods were divided into classes, to indicate which ones present a possible problem due to increases in concentration during processing. Examples were cited of measures taken to eliminate the danger of excessive concentration of fluoride in processed foods.

MARYLAND SECTION

Seventy-five members and guests were present at the March meeting of the Maryland Section, which was held at the Stafford Hotel, Baltimore, Maryland, on Friday, March 12, 1954.

Dr. Glenn G. Slocum, Chief, Division of Microbiology, Food and Drug Administration, gave a most interesting and informative talk on the subject of "Bacterial Food Poisoning." He discussed the trends in food poisoning outbreaks from 1940 to 1950. He pointed out that cases resulting from water and milk products were on the decrease but that cases resulting from other food products were on the increase. He said that with the exception of cases due to *Clostridium Botulinum*, all other food poisonings caused by processed foods are of the gastro enteritis type. Staphylococcus type organisms are the most important in food poisoning outbreaks, followed by Salmonella types. *Streptococcus, E. Coli, Proteus,* and *Cl. Welchii* occasionally give trouble.

All phases of the processing industry were represented at the meeting, and a lively question-and-answer period followed Dr. Slocum's formal presentation.

DR. JAMES A. REYNIERS, NOTRE DAME UNIVERSITY, TO RECEIVE PASTEUR AWARD OF SOCIETY OF ILLINOIS BACTERIOLOGISTS

On Saturday, May 22, at the Edgewater Beach Hotel, the Pasteur Award of the Society of Illinois Bacteriologists will be bestowed upon Dr. James A. Reyniers, Research Professor of Bacteriology at Notre Dame University. The award will be presented at the banquet to be held at 7:00 p.m. in the Grand Ballroom. Following the banquet Dr. Reyniers will address the group and describe the development of the germ-free technic by means of which animals are born, live their normal life space, and die without ever coming in contact with germs of any kind. The technic has attracted wide interest among scientists in the United States and abroad. The findings should have wide applications, particularly in such fields as physiology, nutrition, and food research.

FUTURE DATES FOR FOOD TECHNOLOGISTS

1954	
May 2-5	Annual Meeting of the National Fisheries Institute, Cleveland, Ohio
May 16-19	Flavoring Extract Manufacturers' Association, Biltmore Hotel, New York, N. Y.
May 19	Fruit and Syrup Manufacturers' Association, New York, N. Y.
May 22	Pasteur Award Meeting, Society of Illinois Bacteriologists, Edgewater Beach Hotel, Chicago
May 26-28	*Fourth Annual Convention, Australian Regional Section, Institute of Food Technologists, Leura, New South Wales, Australia.*
June 17, 18	Annual Meeting of the National Live Stock and Meat Board, Conrad Hilton Hotel, Chicago
June 23-25	Seventh Annual Meeting of the Research and Development Associates, Food and Container Institute, Los Angeles, California
June 27 to July 1, 1954	**Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California**

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

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IT'S *ONLY* AS GOOD AS ITS *FLAVOR!*

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Books

ADVANCES IN PROTEIN CHEMISTRY, Vol. VIII. Edited by M. L. Anson, K. Bailey, and J. T. Edsall, Academic Press, Inc., New York (1953), 486 pages plus index. $10.50.

The rapid progress of research on proteins is revealed annually by the appearance of the next of this valuable review series. As in previous volumes, a wealth of information is available in this one. The food technologist will probably find much of the information too far removed from his field of interest to be immediately helpful. Such chapters as "Assimilation of Amino Acids by Gram Positive Bacteria and Some Actions of Antibiotics Thereon" (Gale), 'Bacteriophages, Nature and Reproduction" (Putnam) and "Rotational Brownian Motion and Polarization of the Fluorescence of Solutions" (Weber) are examples. On the other hand, the comparatively short review on "Peanut Protein, Isolation, Composition, and Properties" (Arthur) includes all of the information available about the protein components of this important food and reviews briefly other important facts about the peanut crop.

The most comprehensive review, that on "Naturally-Occurring Peptides" (Bricas and Fromageot) makes extremely interesting reading. All of the antibiotics, vitamins, coenzymes, hormones, toxins, and other biologically active substances that contain the peptide bond are covered (666 references).

Other chapters are on "Peptide Bond Formation" (Borsook), a topic of immediate interest to biochemists because information on the hitherto unknown mechanisms of biosynthesis of proteins is rapidly being collected, and "Zone Electrophoresis" (Tiselius and Flodin), a timely review of a valuable new technique which combines the helpful fractionating properties of both chromatography and electrophoresis.

This series is a must for any library that aspires to cover the subject of proteins. The book is well bound, printed and edited.

HAROLD S. OLCOTT
Albany, California

THE CHEMISTRY AND TECHNOLOGY OF FRUIT AND VEGETABLE JUICE PRODUCTION. Donald K. Tressler and Maynard A. Joslyn. The Avi Publishing Company, 31 Union Square, New York, N. Y. 1954. 962 pp. $15.00.

This completely revised and greatly enlarged edition of "Fruit and Vegetable Juices" published in 1939 is now strictly up-to-date. Perhaps the greatest advance in the juice industries has been the development of frozen concentrates. Today, the use of high-temperature, short-time pasteurization methods are almost universal —as compared with "holding" or batch methods of two decades ago. The present edition contains much new material—new chapters have been added on Sterilization Filtration and Chemical Preservation, Storage Changes, Jelly Manufacture, Dehydrated Fruit Products, Volatile Flavor Recovery, Standards and Regulations, Plant Sanitation, Quality Control, Laboratory Examination, Blended Fruit Juices and Home Preparation and Preservation.

The authors have wisely collaborated with twenty well-known authorities in the field of food preservation to make this book outstanding and authoritative. The technology is not limited to American developments alone, but covers Canadian, European and Australian work as well. The bibliography which follows each of the 30 chapters is most useful. Some 163 illustrations add materially to the interest and value of the text. A unique but valuable chapter deals with "Blending Formulae and Syrup Algebra." The book is carefully and attractively printed and with remarkably few errors. Obviously, this praiseworthy and timely undertaking will be welcomed by food technologists, engineers and chemists in the classroom, library, research laboratory and the plant.

CARL R. FELLERS
Amherst, Massachusetts

PREVENTION OF COPPER AND IRON TURBIDITIES IN WINE. M. A. Joslyn and Aaron Lukton. HILGARDIA, Volume 22, No. 14, 451-533 (1953). Single copies, free on request, as long as the supply lasts, from Publications Office, College of Agriculture, Berkeley 4, California.

This HILGARDIA monograph by Joslyn and Lukton is devoted to a problem in wine stabilization of great current importance; namely, a satisfactory substitute for potassium ferrocyanide to remove copper from wine to intercept the formation of copper casse. The authors review the literature on the tolerance of wine for metals, the corrodibility of metals by wines, the structure and composition of heavy metal ferrocyanides, and the toxicology of ferrocyanide and possible substitutes therefor. There is an analytical section describing methods used for the determination of copper, iron, phosphorus, and tannin, followed by a section on the removal of copper and iron by the addition of selected organic compounds, by special preparations, by naturally occurring nontoxic substances to form precipitates with copper and iron, and by several ion-exchange resins. Comparative data are given on the rate of formation and precipitation of iron ferrocyanides and copper rubeanate. It is shown that both the type of wine and its initial copper content affect the removal of copper by rubeanic acid. Sequestering of copper and iron by various binding agents is discussed. The concluding section relates to the effectiveness of hard chrome plating of winery processing machinery as a means of reducing copper and iron pick-up during processing. On the basis of preliminary investigations the authors are encouraged to believe that hard chrome-plating can be improved to the point where it might be a "practical means of salvaging corrodible winery equipment now in use."

M. S. P.

The greatest improvement in leavening agents in years... PY-RAN

FACT 1: **What PY-RAN does for you** . . . gives leavening *stability* never before possible.

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FACT 6: **Other PY-RAN advantages** . . . slow, controlled release of gas, as produced by PY-RAN, gives excellent texture and volume, plus good crust and crumb color. Tunneling is virtually eliminated.

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FACT 8: **Information** . . . to get accurate, authentic information on PY-RAN or copy of new booklet, "MONSANTO PHOSPHATE LEAVENING AGENTS," write to MONSANTO CHEMICAL COMPANY, Inorganic Chemicals Division, 1700 South Second Street, St. Louis 4, Missouri.

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ideal for machine doughnut mixes

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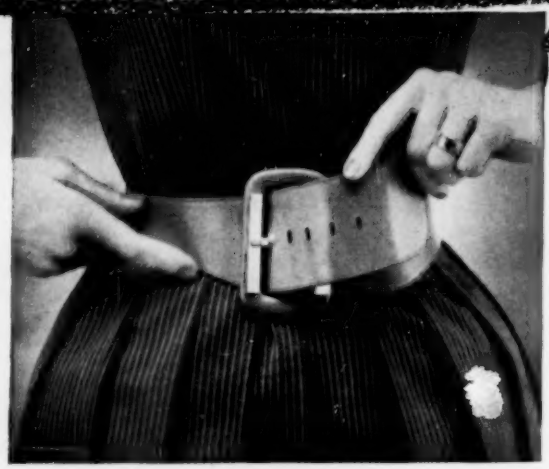
New medical research findings say yes—every healthy person can

Your appetite is what regulates your waistline

Your blood sugar level helps regulate your appetite

When your blood sugar level is low, your appetite goes up—you're apt to eat more calories than you need

When your blood sugar level is high you are more quickly satisfied on fewer calories



Here's how a sensible use of sugar and the good things containing it can raise your blood sugar level—help you stick to your diet

Research scientists at a leading university have discovered that, if you are a healthy person, your blood sugar level plays a most important part in your body's own weight-control system.

What this means to you, if your weight is normal, is that you can go right on enjoying as much sugar in your foods and beverages as you always have—without worrying about it or any other food "making you fat."

But if you are *overweight*, a moderate use of sugar in your diet may actually be *more effective* in helping you reduce than no-calorie artificial sweeteners.

Nature's "hunger regulator"

There is only one kind of calories that can make you fat. These are the *extra* calories you get when you *overeat*. And one of the most effective things you can do to help keep from overeating is deliberately to eat or drink something sweetened with sugar just before a meal, or during the early part of a meal.

The scientific reason for this, just now becoming more clearly understood, is that your *blood sugar level* acts as a hunger regulator. When it is *low* your appetite is geared up to a hearty, heavy meal with second helpings. When your blood sugar level is *high*, your appetite is slowed down to a one-helping pace.

Eating a big meal, even if it contained no sugar at all, would eventually raise your blood sugar level to the point where it would "shut off" your appetite. But the big idea is to raise it quickly—before you've already eaten too much.

Sugar is absorbed almost *instantly*—faster than any other food. That's why even an 18 calorie teaspoonful in your coffee or tea can make it easier for you to turn down several times as many calories later on.

Helps make a small meal more satisfying

There is still another reason, based on a quite different nutritional principle, why overweight people are often told to include a simple dessert in their drastically curtailed calorie allowance. It is the fact that a meal that contains some sugar has a greater *satisfaction value* than the same meal without sugar. The sense of satisfaction stays with you for a longer time, helps to keep you from getting as hungry between meals.

No "magic" short cuts to losing weight

Many people feel that using a sugar substitute or giving up their favorite dessert is all they have to do to solve their overweight problem. Actually, reducing isn't that easy, although anything that will make it easier for you to stick faithfully to your diet (as sugar can) is a big help.

Losing weight *does* require *dieting*, and your diet should be planned by a doctor. He will tell you that there are no "magic secrets" or safe and sure "short cuts" to reducing. But follow his advice and you *will* lose weight.

You will have to eat smaller meals, but you won't have to give up any good food that is important to your health. To deny yourself sugar would be to make weight control more difficult than it need be.

SUGAR INFORMATION, INC.
New York 5, New York

18 CALORIES

Surprise you that there are only 18 calories in a level teaspoonful of sugar? Compare this with the 2,500 a moderately active woman (125 lbs.) uses up every day. An average 154-pound man won't gain weight on 2,000 calories a day.

All facts in this message apply to both cane and beet sugar.

The SECOND AD in sugar's new campaign asks a question ... on many people's minds—and gives them the kind of ... they (and you) like to hear. Millions of people will ... full-page ad, in LIFE—April 5, THE SATURDAY ...—April 24, LADIES' HOME JOURNAL for May, ...—May 15, and LOOK—May 18. 39 BIG-CITY ... from coast to coast will also carry it the week

YES

Sugar Industry's New Advertising Explodes a Nutritional Bombshell

People are still talking about the first ad in sugar's new campaign—the ad that answered the question, "What makes people fat?"

While interest is still at a high pitch, here's another—right on the same target!

Consumers are learning from this advertising something that they strongly suspected right along—that *artificial sweeteners can't take the place of sugar!*

They are gaining from it the *reassurance* to go right on reaching for their favorite foods and beverages that contain sugar.

This reassurance is based on an accurate and straightforward reporting of findings in a medical research project of fundamental importance—the fact that *sugar plays a leading role in the body's own weight-control system.*

It's a mighty effective answer to the confused calorie claims that seek to undermine confidence in quality foods and beverages that you have helped to build up over the years.

Don't you agree that this positive approach by sugar is a big step in the right direction? And as the campaign gains momentum, isn't it bound to build a greater appreciation of the sugar-containing products you make, distribute or sell?

SUGAR INFORMATION, INC.
New York 5, New York

Selected Abstracts*

ANALYTICAL METHODS

Food analysis. Identification of enzyme-desugarized egg solids.
SCOTT, D. *J. Agr. Food Chem., 1,* 1109-11 (1953).

Qual. tests for gluconic acids in enzyme desugared egg solids are described.

A method for determination of lactose in milk by paper chromatography.
HONER, C. J., AND TUCKEY, S. L. *J. Dairy Sci., 36,* 1233-40 (1953).

Direct application of milk to the strip and subsequent detn. of lactose on the chromatostrip after partitioning are desirable features of the procedure. The reproducibility of the method was detd. for lactose in pure soln. and in milk. At a mean value of 4.516% lactose, anhydrous, in milk the optimum standard deviation was 0.16%. The recovery from milk of added lactose, anhydrous, varied between 92 and 97% and averaged 95%.

Determination of ascorbic acid by a new colorimetric reaction.
SCHMALL, M., PIFER, C. W., AND WOLLISH, E. G. *Anal. Chem., 25,* 1486-90 (1953).

A new assay method for ascorbic acid involves the reaction with diazotized 4-methoxy-2-nitroaniline in acid medium, followed by development of a blue color in alk. soln. The method is highly specific for the detn. of ascorbic acid in the presence of dehydroascorbic acid and all other vitamins normally found in pharmaceutical prepns. It has also been applied to various fruit juices and processed foods.

Rapid determination of blood acetone and blood glucose.
YAGER, I. *J. Lab. Clin. Med., 42,* 474-8 (1953).

The need for a simple test for blood sugar and acetone levels, which does not require elaborate equipment and is not time consuming, is stressed. A method of obtaining these levels with virtual "bedside" technic, based on modification of Kleeberg-Moore's test and Legal's acetone test, is presented. While this test is not meant to be a sensitive quant. test, or to replace the standard detns. of this sort, it is offered as a valuable means of obtaining information which ordinarily would not be available due to lack of equipment or necessity for speed. The results of several cases are listed, as well as comparison of results with the standard Folin-Wu method.

Infrared spectra of some lipoproteins and related lipides.
FREEMAN, N. K., LINDGREN, F. T., NG, Y. C., AND NICHOLS, A. V.

The i. r. absorption spectra of some ultracentrifugally isolated serum lipoproteins and those of some related lipides were presented and discussed. In a lipoprotein spectrum the relative intensities of the ester carbonyl band and certain strong bands of proteins can serve as a rough gage of the lipid-protein ratio. Other absorption bands were correlated with those of the principal component mols. making up the lipoprotein. A rudimentary method for quant. analysis of these mols. and of lipide mixts. by i. r. methods were described and improvements suggested.

Identification of complex organic materials by infrared spectra of their pyrolysis products.
HARMS, D. L. *Anal. Chem., 25,* 1140-55 (1953).

Many materials of rubber, plastic, and resinous compn. are not adapted to i. r. analysis by conventional technic because of their phys. intractability. The dry distn. products of these complex materials frequently will permit the prepn. of a reproducible i. r. spectrum which will be characteristic of the original material and can be compared empirically with spectra of physically similar materials of known compn. treated in the same manner to provide rapid, qual. identification. A very simple method for producing the pyrolyzate is developed. A representative collection of spectra, indicating how comparisons are made together with a synopsis of bands useful in identifying the original material, reveals the applications and limitations of the method. Several examples of the pyrolyzate-i. r. approach to typical problems are given to illustrate the unusual rapidity and utility of the procedure as compared to any other known method.

Analytical studies on harvested tobacco leaves.
FRANKENBURG, W. G., GOTTSCHO, A. M., KISSINGER, S., BENDER, D., AND EHRLICH, M.

A scheme of analysis was devised to permit not only detn. of the known constituents, but also classification of the unknown N compds. in tobacco leaves. This comprehensive scheme involves the stepwise removal of definite nitrogenous fractions from a water ext. of a tobacco sample and the detn. of the nitrogenous compds. in these fractions. The method is of value for the exploration of N compds. contained in different types of tobacco at various stages of their industrial processing and gives a complete accounting of the changes in nitrogenous compds. that occur during these stages. The method may lend itself equally well to N detn. in other plant material.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Some chemical aspects of normal growth.
BERGEL, F. *Nature, 172,* 905-8 (1953).

A review of the recent hypothesis of intracellular growth with special emphasis on the role of nucleic acids. An hypothesis is presented in which the central role of nucleic acids is refuted, these acting rather as a backbone on which are placed proteins which act as the actual templates for protein synthesis.

Role of choline in the oxidation of fatty acids by the liver.
ARTOM, C. *J. Biol. Chem., 205,* 101-11 (1953).

The findings presented suggest that the lipotropic effect of choline may result, at least to a large extent, from the enhancement of fatty acid oxidation in the liver under the action of some substances formed from choline *in vivo*.

Human esterases.
GOMORI, G. *J. Lab. Clin. Med., 42,* 445-53 (1953).

A simplified azo-dye method for the quant. detn. of phenols and naphthols is described. The enzymatic profiles of human esterases of liver, pancreas, serum, and urine, obtained by the use of phenolic substrates, are presented. The specific features of these enzymes are discussed. Human serum esterase is identified as a cholinesterase.

Complementary enzyme actions in the clotting of milk.
HEINICKE, R. M. *Science, 118,* 753-4 (1953).

It is claimed that the clotting of milk by rennin or pepsin is a 3 step reaction. The enzyme destabilizes the casein mol., moderate thermal energy denatures the enzyme-modified mol., and polyvalent cations crosslink the extended polypeptide chains into a coherent clot. Data is given to show that a low-temp. milk-clotting combination is possible by combining a rennin-like enzyme with a protein-splitting enzyme.

Metabolic fate of S^{35} in the lactating cow when fed $S^{35}O_2$ preserved silage.
KEENER, H. A., TEERI, A. E., HARRINGTON, R. V., AND BALDWIN, R. R.

Approx. two-thirds of the S^{35} fed was absorbed and then for the most part eliminated by the kidneys. The fact that S from the $S^{35}O_2$ was synthesized into the proteins of the blood and of the milk indicates that it may be of value from a nutritional standpoint. These results suggest the desirability of detg. any effects on the kidneys from feeding relatively large amts. of inorg. sulfates to dairy cattle.

NUTRITION

Effects of mineral deficiencies on amino acid utilization. Critical role of potassium and phosphorus.
FROST, D. V., AND SANDY, H. R. *Proc. Soc. Exptl. Biol. Med., 83,* 102-5 (1953).

Results of this study point to the crit. role of K in amino acid utilization following protein depletion. Rats depleted only of protein failed completely, even when offered a complete source

(Continued on page 24)

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

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SELECTED ABSTRACTS

(Continued from page 22)

of amino acids, if at the same time K was withheld. If P was withheld during the repletion period, the rate of recovery was lessened, but complete failure and deaths did not result as with K deprivation. Deprivation of Na, Ca or Mg did not appear to have immediate limiting effects on the appetite of protein depleted rats for a complete amino acid source, or on their ability to recover lost wt. Fourteen mg. of K per rat day appeared to meet the requirement for this element. Addn. of 10 mequiv. of K per l. to an intravenous protein hydrolyzate appears to supply an effective, safe ratio of K to amino acid N.

Differential dietary choices of albino rats occasioned by swimming.

GRIFFITHS, W. J., AND GALLAGHER, T. J. *Science, 118,* 780 (1953).

Male albino rats were offered a 20% soln. of dextrose, a 0.15% soln. of saccharine distd. water and a McCollum stock diet in solid form. The animals were given an 8 day "rest period" followed by a 14 day interval during which they were swum daily in warm water for an av. of 1 hr. 50 min. or until distress was evident. Significantly more dextrose was consumed during the swimming period in comparison with the rest period. No significant differences were found in the amts. of saccharine and McCollum diet chosen during the two periods. It is concluded that rats tend to prefer a calorically valuable substance to a similar tasting but calorically useless substance when forced to expend energy.

The metabolism of ethyl alcohol.

MARSHALL, E. K., AND FRITZ, W. F. *J. Pharmacol. Exptl. Therap., 109,* 431-43 (1953).

The independence of the rate of oxidation of alc. on the amount present in the organism is only apparently true for relatively high concns. in plasma. At very low concns., in accordance with data obtained on other drugs, the rate of disappearance of alc. from the plasma (oxidation) is proportional to the amount present.

Amino acid requirements of man.

ALLISON, J. B. *Borden's Rev. Nutr. Research, 14,* 61-79 (1953).

Topics discussed include the concept of N balance, effect of food processing and digestion, amino acids from food proteins, nutritive value of proteins, the repletion problem and the calorie problem. 76 references.

Algae as food.

MILNER, H. W. *Sci. American, 189,* 31-6, October, 1953.

It is estd. that Chlorella could produce about 40 tons of food per acre of cultivation. By varying conditions, Chlorella with just about any desired percentage of protein, carbohydrate or fat could be produced. Palatability has not been thoroughly investigated, but there seem to be no adverse effects, when fed to laboratory animals or upon limited addn. to human diets. Due to need of special technics, it is highly improbable that Chlorella can be grown in home "gardens."

Effect of stress upon the healing of wounds in rats.

CHASSIN, J. L., MCDOUGALL, H. A., MACKAY, M., AND LOCALIO, S. A. *Proc. Soc. Exptl. Biol. Med., 83,* 798-801 (1953).

A variety of situations, calcd. to provide a chronic "stress" stimulus, were studied in order to det. the effect of stress upon the bursting pressure of standard laparotomy wounds in rats.

PHARMACOLOGY AND TOXICOLOGY

Experimental production of liposarcomas in the rabbit by the trace elements zinc and cobalt.

THOMAS, J. A., AND THIERT, J. P. *Compt. rend., 236,* 1387-9 (1953); *Nutrition Abstr. & Revs., 23,* 871, No. 4802 (1953).

Rabbits which had been fed on a diet of oats and bran for 9 months and had become excessively fat received on 5 successive days subcutaneous injections of 1 mg. Co or Zn as sol. salts in physiological saline or deproteinized amniotic fluid. They rapidly lost wt. and fat and after 22-37 days with Co or 24-36 days with Zn developed liposarcomas symmetrically in the centers of the right and left lumbar fat deposits. The sarcomas required

(Continued on page 28 following technical papers)

Effect of Calcium Removal by Ion Exchange on the Properties of Fluid Milk[a,b]

RICHARD D. COLEMAN, SOLOMON J. BISHOV, J. H. MITCHELL, JR.
Quartermaster Food and Container Institute for the Armed Forces,[c] Chicago, Ill.

(Manuscript received August 20, 1953)

High temperature heat treatment of milk to increase resistance to lipid oxidation is a commercial practice in the manufacture of dry whole milk and other dairy products. Denaturation of serum proteins and lowered dispersibility of casein are often undesirable resultants of this treatment. Evidence exists that partial removal of calcium from milk increases the resistance of proteins to heat-induced changes. This paper describes the use of synthetic resinous ion exchangers in the removal of calcium from milk. A larger portion of calcium may be removed from milk with less change in sensory rating by the use of anionic and cationic resins in intimate mixture than by the use of these resins singly or in series.

At present, high temperature preheating of milk in the manufacture of dry whole milk is commercially practiced. The increased resistance of the milk lipids to oxidation resulting from preheat treatment is thought to be due to antioxygenic sulfhydryl compounds liberated principally from the serum protein fraction of the milk *(15, 6)*. Although advantageous from the standpoint of lipid stabilization, high temperature preheating may result in certain undesirable changes, among which is the effect on milk proteins, the denaturation of serum proteins, and the destabilization of casein rendering it less dispersible and therefore the dry milk less "soluble." Thus initiated, a continuing loss in solubility during storage may result *(12)*. The effect of heat treatment on milk proteins has been discussed in a recent review *(1)*.

A characteristic tactual defect often noted in reconstituted dry milk and in evaporated milk described as "rough," "chalky," or "astringent" is said to be the result of heat-induced denaturation of serum proteins *(7)*. The importance of salt composition in the heat coagulation of fresh and evaporated milk was first discussed by Sommer and Hart *(14)*. As related to heat coagulation, calcium appears to be the controlling ion in the salt system of milk *(4)*. An excess of calcium increases the instability of milk proteins during heat processing.

Although it has been a commercial practice for many years to increase the heat stability of evaporated milk by binding excess calcium with such added salts as sodium citrate or disodium phosphate, it is only since the work of Lyman *(11)* in 1933 that ion-exchange materials have been used to modify the mineral constituents of milk, chiefly to decrease calcium. Varied application of the exchange procedure has since been reported. A frozen milk of normal flavor and with improved physical stability has been obtained by removal of as little as 10-15% of the calcium *(5)*. Other workers have reported, however, that although a retarding effect on casein flocculation in frozen milk products is accomplished by calcium removal, using a cationic exchange procedure, an adverse effect on flavor appears to limit the utility of such treatment *(16)*. Ion exchanged milk added as a fluid, powder, or concentrate to evaporated milk was found capable of stabilizing the product against coagulation during sterilization *(8)*. Powdered cream readily reliquefiable and stable to heat coagulation has been produced by ion-exchange treatment to lower the calcium content before drying *(2)*. Ion exchange has also been used to convert insoluble acid caseinate into a soluble alkali-metal caseinate of reduced ash content *(2)* and to produce smoother ice cream *(3)*. The theory and general application of ion exchange has been reviewed recently by Kunin *(9)*, Kunin and Myers *(10)*, and Nachod *(13)*.

EXPERIMENTAL

The principal objective of the work here described was to determine, preliminary to heat treatment studies and spray drying, the maximum extent of demineralization (specifically, calcium removal) of fluid milk, using synthetic ion exchange resins, consistent with a high sensory evaluation of the treated milk.

Resinous cation exchangers were employed in this study either in the hydrogen cycle, i.e., the resins were regenerated to contain exchangeable hydrogen ions, or in the sodium cycle, i.e., the resins were regenerated to contain exchangeable sodium ions. The resinous anion exchangers, used in conjunction with the hydrogen form of the cation exchanger to remove by adsorption acids formed in cationic exchange, were regenerated with sodium or ammonium hydroxide.

The ion exchange process was conducted in two ways: (a) by batch operation and (b) by column operation.

A mixed-bed procedure recently introduced[d] is a column procedure employing an intimate mixture of cationic and anionic exchange resins in a single bed.

As applied to milk, the mixed-bed procedure offers definite advantage over the procedures described previously. By the use of a mixture of a weakly acidic cationic resin and a weakly basic anionic resin the demineralization is controlled within a relatively narrow range of pH about neutrality. The procedure for mixed-bed demineralization as used in this study is described later in some detail.

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[a] This paper reports research undertaken at the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 444 in the series of papers approved for publication. The view or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

[b] Presented at the Thirteenth Annual Meeting of the Institute of Food Technologists, Boston, Massachusetts, June 23, 1953.

[c] A field installation of the Research and Development Command, Office of the Quartermaster General.

[d] Termed *Monobed* by the Resinous Products Division, Rohm and Haas Co. See *Amberlite Monobed Deionization*, Rohm and Haas Co., page 8.

TABLE 1

Ion exchange resins used in the demineralization of milk

Resin	Amberlite IR-100	Amberlite IRC-50	Amberlite IR-120	Amberlite IR-4B	Amberlite IRA-400	Amberlite IR-45
Exchanger type	Cation	Cation	Cation	Anion	Anion	Anion
Active group	Sulfonic	Carboxylic	Sulfonic	Modified amine	Modified amine	Modified amine
Behavior	Strongly acidic	Weakly basic	Strongly acidic	Weakly basic	Strongly basic	Weakly basic

The synthetic resinous exchangers used were commercial products designated as Amberlites. Table 1 lists the types of resins used.

Use of cationic exchange resins by the batch technique. The cationic exchange resin, Amberlite IR-100, in the acid cycle (IR-100-H) was added with agitation to aliquots of homogenized whole milk in amounts sufficient to result in a series with decreasing calcium values. The milk was separated from the resin by decantation and filtered through cheese cloth.

This procedure was repeated with other aliquots of untreated milk except that the sodium form of the cationic resin (IR-100-Na) was used subsequent to the acid form to readjust the pH of the milks to the initial value. The combination of resins was also employed in the reverse order.

The resin-treated samples were judged by a 17-member milk panel using a 9-point quality rating scale in which: 9 was *excellent*; 8, *very good*; 7, *good*; 6, *below good but above fair*; 4, *below fair but above poor*; 3, *poor*; 2, *very poor*; and 1, *extremely poor*. Results obtained (Table 2) are plotted as a function of calcium content in Figure 1.

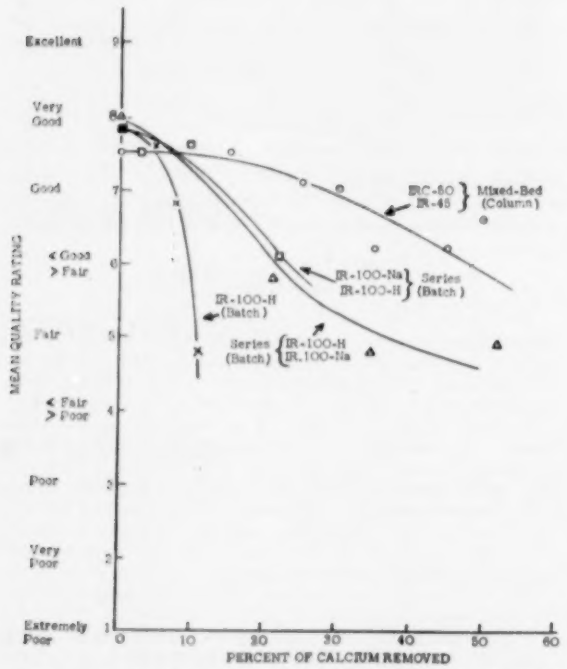

Figure 1. Quality ratings for batch-treated and mixed-bed demineralized whole milk.

From sensory considerations, the factors limiting extent of exchange were the resultant acidity when the resin was used in the hydrogen cycle and resultant saltiness where the resin was used in the sodium cycle or where the resin was employed in both cycles in sequence. Thus, by the use of the cationic exchanger in the hydrogen cycle demineralization equivalent to approximately 10% calcium removal with only slight changes in sensory evaluation was obtained whereas only slight flavor changes were produced by removal of approximately 20% calcium using both forms of the resin in series.

Theoretically, it appeared that further calcium removal without an appreciably lowered sensory score could have been accomplished through the use of a cation exchanger in the hydrogen cycle followed by an acid adsorbing resin (anionic exchanger); however, in practice, this was not possible due to the low efficiency of the latter in milk as seen below.

TABLE 2

Effects of various cationic batch exchange treatments of fluid whole milk on extent of calcium removal and milk panel rating

pH				% Calcium removed	Mean panel rating[1]
Initial	After IR-100-H	After IR-100-Na	After IR-100-H		
6.7	6.4			4	
6.7	6.2			7	
6.7	5.8			14	
6.7	5.5			18	
6.7		6.8		2	
6.7		6.9		5	
6.7		7.0		10	
6.7		7.5		18	
6.7		8.3		32	
6.7		9.3		41	
6.6				0	7.8
6.6	6.3			5	7.6
6.6	6.2			7	6.8
6.6	5.9			11	4.8
6.6		6.7	6.5	3	7.5
6.6		6.7	6.6	9	7.6
6.6		6.9	6.6	22	6.1
6.7				0	8.0
6.7	6.3	6.6		21	5.8
6.7	6.2	6.6		35	4.8
6.7	5.9	6.6		52	4.9
6.7	6.0	6.4		91	3.2

[1] Using a 9-point rating scale where 9 is *excellent* and 1 is *extremely poor*.

Use of cationic and anionic exchange resins by the batch technique. Homogenized whole milk was stirred with IR-100-H, separated by decantation and filtered through cheese cloth and aliquots were then stirred with the anionic resins IR-4B or IRA-400 until the pH remained constant and the milks were again separated.

As seen in Table 3, neither of the anionic resins, although employed in large amounts, removed the acidity resulting from cationic exchange.

TABLE 3

Effect of batchwise use of cationic and anionic resins in series on pH and extent of calcium removal from fluid milk

pH				Total calcium removed (%)
Initial	IR-100-H	IR-4B	IRA-400	
6.5	6.1	6.2		12
6.5	6.1		6.1	11

Phosphate buffered and unbuffered acidic solutions (HCl) containing either calcium chloride or casein or a mixture of the two were batch-treated with the acid adsorbing resin, IR-4B. The concentration of calcium, casein, and phosphorus of buffered solutions approximated their concentration in fluid milk. Calcium chloride alone did not affect the ability of IR-4B to adsorb

acid. Both the buffer ($KH_2PO_4 \pm Na_2HPO_4$) and casein considerably increased the weight of resin required to effect a pH change. In the presence of casein and/or buffer the activity of IR-4B was so reduced as to be negligible even though large amounts of resin were used.

Use of cationic and anionic exchange resins by the mixed-bed column technique. A recent exchange technique involving an intimate mixture of an anion and cation exchanger appeared to offer advantages, cited earlier, over the two cycle systems.

The general mixed-bed procedure used in this study is described in some detail.

The ion exchange column consisted of a Pyrex glass tube 48 inches long and 1.5 inches in diameter having a drawn tip at one end. The column was charged as shown in Figure 2 with a

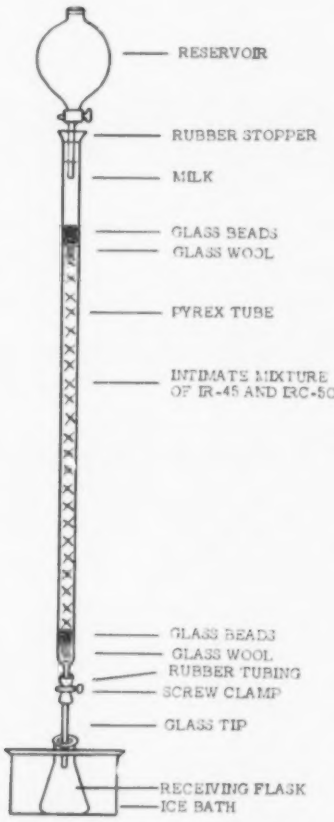

Figure 2. Ion exchange column.

mixture of equal volumes of Amberlites IR-45 and IRC-50.[e,f]

Glass wool was placed at the bottom of the exchange column to form a mat approximately one inch in depth. Above this, glass beads of approximately 5 mm. diameter were placed to a depth of one inch. The column was charged with 600 ml. (wet volume) of a mixture of equal volumes[e] of "Amberlites" IR-45 and IRC-50 in the following manner: the lower clamp was closed and approximately 50 ml. of distilled water placed in the column; the mixing rod[h] was placed in the column spiral, tip down, the mixed resins placed in the column in increments of approximately 200 ml. with vertical agitation by the mixing rod. The purpose of the water was to allow the resin to settle in a manner which avoided air pockets and channeling. The mixing rod was removed and after the resin mixture had settled the water was drained to a level approximately one inch above the resin. Glass wool to form a mat approximately one inch in depth was next inserted above the resin bed and above the mat were placed glass beads to a depth of one inch to anchor the mat. The reservoir was then attached at the top by means of a rubber stopper.

Milk was passed downflow through the column at the rate of 10 ml. per minute. A column of milk above the resin bed was maintained at a height sufficient to permit a controlled rate of flow throughout the demineralization. The temperature of the influent milk was 5-10° C. The effluent milk was collected in a flask held in an ice bath. The first liter of effluent collected, containing displaced water from the column, was discarded.

The treated milk of reduced calcium content was combined and mixed with untreated milk to give milk of any desired calcium content.

After the resin-treated milk had been collected, hot tap water was passed rapidly downflow through the column until no turbidity was evident in the effluent. The resin bed was then transferred to a tall cylinder and backwashed by introducing hot tap water upflow from the bottom of the column at a rate which resulted in a separation of the 2 resins. The water pressure was increased causing the less dense IR-45 to rise and spill over into a collecting pan while the more dense IRC-50 remained. The IR-45 was transferred to a cylinder and both resins thoroughly backwashed with hot tap water. Each of the resins was then transferred to an exchange-type column and regenerated downflow: IRC-50 using 6% HCl, IR-45 using 6% NH_4OH, both using one liter of regenerant per 300 ml. (wet volume) of resin. Each resin was then washed downflow with deionized water until the pH of the effluent wash became constant.

EVALUATION OF MIXED-BED COLUMN METHOD

Both whole and non-fat milk were treated by the mixed-bed column method described.

Non-fat milk of varying calcium content was tested by the milk panel by a method which measured the degree of difference between treated samples and an untreated non-fat milk. Coded controls were evaluated with the coded treated samples. For this test a 10-point scale was used in which the control was arbitrarily asigned a value of 0. A numerical value of 0.5 to 3.5 represented a slight degree of difference between treated sample and control, 3.5 to 6.5 a moderate difference and 6.5 to 10 a difference varying from large to extreme.

The degree-of-difference data for several tests compiled and averaged are shown in Table 5 and are plotted in Figure 3. Approximately 30% of the calcium of skim milk may be removed by the mixed-bed method with but a slight difference between resin-treated samples and control.

[e] A lot of Amberlite IR-45 was found to impart a marked toluene-like odor and foreign flavor to milk treated with it. This contamination was obviated by heating the resin in a forced-draft oven at 80° C.

[f] The resins, though supplied in an active form ready for use, should be backwashed prior to use to remove any excess regenerant and to obtain resin samples of approximately uniform particle size. In backwashing the resin is placed in either a tall cylinder or an exchange column and distilled or deionized water is introduced upflow from the bottom of the column at a rate sufficient to cause approximately a 50% bed expansion and the flow is continued until the finer material has been washed up and out and the effluent water reaches a constant pH.

[g] It was found subsequent to this work that a mixture of IR-45 and IRC-50 in the ratio of 3:2 gave the least amount of change in pH of the effluent milk as compared with influent.

[h] A steel rod 60 inches in length and $\frac{3}{32}$ inches in diameter having at one end a spiral twist 3 inches in length was used to mix the resins in the exchange column.

The principal flavor change reported for treated non-fat milk samples was increased "wateriness." Wateriness appears to be the result of a physical change in the colloid as was evidenced by a marked decrease in optical density as extent of demineralization was increased as shown in Table 6 and Figure 4. Essentially no loss in Kjeldahl nitrogen (less than 2%), a 6% loss in total solids, and a pH drop averaging 0.3 were observed with

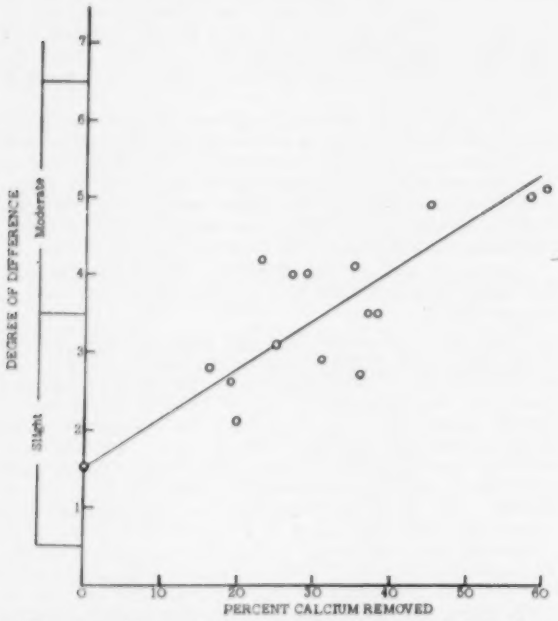

Figure 3. Degree of difference between mixed-bed demineralized non-fat milk and untreated control.

samples demineralized to the extent of 90% calcium removal.

Whole milk of varying calcium content, prepared by the mixed-bed procedure described, and coded untreated milks were tested by a 20-member milk panel using the 9-point quality rating scale previously described.

Quality ratings for several evaluations of resin-treated whole milk are shown in Table 7. Average ratings are plotted in Figure 1. Demineralization of whole milk equivalent to 50% calcium removal may be accomplished with but a slight lowering in quality rating.

Percent losses of Kjeldahl nitrogen, ash, and fat for

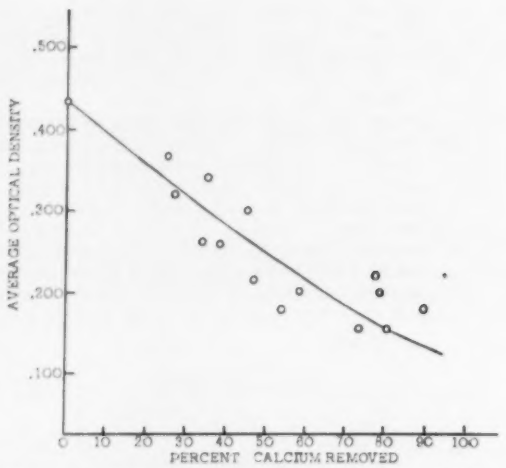

Figure 4. Optical density of 1:100 aqueous dilution of mixed-bed demineralized non-fat milk.

effluent whole milks of varying calcium content shown in Table 8 are plotted in Figure 5. It is seen that with complete decalcification approximately 80% loss of ash had occurred but only 1% of the Kjeldahl nitrogen, and 5% of the fat had been removed.

Using a mixture of IR-45 and IRC-50 in the ratio of 1:1 the pH drop in effluent milks, including those com-

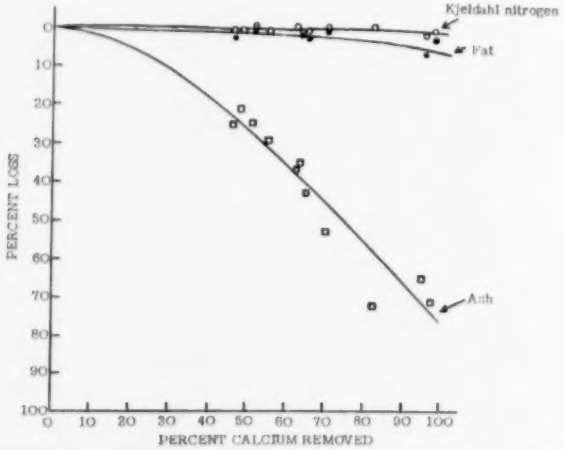

Figure 5. Percent loss of various constituents in whole milk treated by the mixed-bed procedure as a function of the percent calcium removed.

TABLE 5

Degree of difference between mixed-bed demineralized non-fat milk and untreated control using a 10-point rating scale

% Calcium removed	0	16	19	20	23	25	27	29	31	35	36	37	38	45	58	60
Mean degree of difference	1.4			2.1									3.2			5.1
	1.0		2.6									3.5			5.0	
	1.5	2.7			4.2			4.0								
	1.8					3.1				4.1				4.9		
	1.7						4.0						3.8			
	1.9	2.9							2.9		2.7					
Average mean difference	1.5	2.8	2.6	2.1	4.2	3.1	4.0	4.0	2.9	4.1	2.7	3.5	3.5	4.9	5.0	5.1

pletely decalcified, did not exceed 0.3. These resins used subsequent to this work in a ratio of 3:2 have resulted in an effluent pH lowering not exceeding 0.1 for extensively decalcified milks.

TABLE 6
Optical density of mixed-bed demineralized non-fat milk

% Calcium removed	0	25	27	34	35	38	45	47
Average optical density of 1:100 aqueous dilution	.433	.367	.319	.260	.342	.259	.301	.215
% Calcium removed	54	58	73	77	78	80	89	100
Average optical density of 1:100 aqueous dilution	.181	.201	.155	.222	.201	.155	.181	.181

TABLE 7
Quality ratings for mixed-bed demineralized whole milk and untreated control milk using a 9-point rating scale

% Calcium[1] removed	0	15	25	30	35	45	50
Quality rating	7.9	7.7	6.5		5.7		
	7.5		7.7		6.2		6.6
	7.2	7.2		7.0		5.8	
	7.5			7.0		6.6	
Average quality rating	7.5	7.5	7.1	7.0	6.2	6.2	6.6

[1] Cations other than calcium were removed; these data are in process of publication.

TABLE 8
Percent loss of various constituents in whole milk treated by the mixed-bed procedure as a function of the percent calcium removed

% Calcium removed	Nitrogen	Ash	Fat
46	1	25	3
48	1	21	1
51	0	25	1
55	1	29	1
62	0	37	0
63	1	35	2
65	1	43	3
70	0	53	1
82	0	72	0
95	2	68	7
97	1	71	3

SUMMARY

High temperature heat treatment of milk to increase its resistance to lipid oxidation is a commercial practice in the manufacture of dry whole milk and other dairy products. Denaturation of serum proteins, thought by some to be responsible for a tactual defect of reconstituted dry milk, and decreased dispersibility of casein and therefore dry milk are often undesirable resultants of this treatment. Evidence exists that partial removal of calcium from fluid milk increases protein resistance to heat induced changes.

Batch and column procedures for calcium removal employing synthetic cationic resinous exchangers singly, in series with anionic exchangers, and in intimate mixture have been described.

Sensory evaluation and pH change have been employed in comparing exchange methods. More calcium may be removed from milk with less change in sensory rating by the use of cationic and anionic resins in intimate mixture than by the use of the cationic resins either singly or in series with anionic exchangers. With but a comparatively slight change in sensory rating, approximately 10% of the calcium may be removed from whole milk using the hydrogen form of the cationic exchanger, 20% using this form in series with the sodium form, 50% using a mixture of a cationic and anionic resin and 30% from skim milk employing this mixture. Change in pH, even with extensive calcium removal, was slight when the mixed-bed procedure was employed.

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Effect of Storage Temperatures on the Aging of Country-Style Hams

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The effects of storage temperatures on the rate of aging of country-style hams are described, as determined by measurement of typical physical, chemical, and sensory characteristics of aging. Aging was found to be a function of storage time at temperatures of 50°, 68°, and 86° F. but hams did not age properly at 33°, and at 0° there was no aging at all.

Although considerable information has been reported on the chemistry, bacteriology, and technology of curing and smoking, relatively little is available on the aging of country-style hams, especially at below-ambient storage temperatures. Miller and Ziegler *(7)* recommended holding this type of ham at approximately 40° F. (4.4° C.) for 30 days after cure to permit adequate penetration of salt into the center, and Hunt *et al. (6)* used a 2-weeks "air cure" for the same purpose, but in both instances the hams were aged at room temperature or above. These investigators, and Supplee and Broughton *(10)*, demonstrated that characteristic changes accompanying the aging of hams include yellowing and hydrolysis of the fat, increases in total and amino soluble nitrogen as well as in total acidity and red color in the lean, and uniformly decreasing rates of moisture loss and concentration of salt.

With the growth during the last 2 decades of home and community facilities for refrigerated storage, the practice of holding country-style hams under refrigeration until used has become relatively common. This is particularly true in the southeastern area where rancidity, mold, and insect damage, as well as danger of spoilage resulting from inadequate curing, are real problems because of generally high atmospheric temperatures and humidities. The study reported in this paper was conducted in an effort to establish comparative rates of ham aging between refrigeration temperatures and temperatures at or above common storage levels.

EXPERIMENTAL PROCEDURES

The 67 hams used in the study were selected for uniformity of size and weight as they were cut from chilled carcasses in a commercial packing house. The hogs from which they were obtained had been received in 1 lot, from 1 farm, and were slaughtered on the same day. The hams were cured 41 days at 39° F. (3.9° C.) with 2 applications of standard 8-2-2 dry curing mixture (8 pounds salt, 2 pounds sugar, 2 ounces sodium nitrate) totalling 1¼ ounces per pound of meat, and smoked 22 hours with hickory sawdust smoke at 120°-127° F. (49.9°-52.8° C.). The weight per ham averaged 13 pounds 13 ounces ± 14 ounces after smoking.

The smoked hams were divided into 5 lots for storage at 0°, 33°, 50°, 68°, and 86° F. (—17.8°, 0.6°, 10°, 20°, and 30° C.) and examinations were made when stored and after 3, 6, 9, and 12 months. Three hams were examined before storage, and each of the periodic examinations included 2 hams from 0°, 3 from 33°, 4 from 50°, 4 from 68°, and 3 from 86°. During the 12 months' storage period, temperatures were maintained within 2° F. (1.1° C.) of the levels indicated; relative humidities averaged 65% with maximum deviations of 5%.

Examinations of the hams were carried out by 4 operators in order to handle the samples rapidly enough to minimize changes caused by exposure of the cut surfaces to the atmosphere. Each ham was cut just above and parallel to the aitch bone and a 1-inch slice removed for determinations of color and resistance to shear. A second slice, ¾ inch thick, was used for determining moisture, salt, and rancidity. The remaining section up to the stifle joint was cut into ½-inch slices for sensory evaluations of raw and broiled ham.

Four 1-inch cubes were cut from the first slice. Cube 1 was from the center of the semimembranosus muscle *(3)*, cube 2 from the semitendinosus, cube 3 from the biceps femoris, and cube 4 from the rectus femoris and vastus lateralis area (see Table 4). Color was determined on cube 1 by comparison with Lovibond Tintometer standards in blue, yellow, and red. Shear resistance was measured on each of the 4 cubes with an instrument similar to the dynamometer described for such measurements by Black, Warner, and Wilson *(4)*.

The second slice was separated into external fat, internal fat, and lean. Rancidity values were determined on the fat samples as peroxide numbers by the method of Stansby *(9)* and percent free fatty acids by the method of AOCS *(1)*. The lean was ground 3 times in a Universal Food Chopper with a 19-tooth blade, and moisture and salt were determined by the vacuum oven method and the Volhardt method, respectively, as recommended by AOAC *(2)*.

The samples for sensory evaluation were scored on general appearance, color, and aroma in the raw state, and were then pan broiled for scoring on appearance, color, aroma, texture, and flavor. Each quality was scored on a 5-point scale, with 3 indicating an optimum amount of the characteristic under consideration, 2 or 1 a slight or pronounced lack of the desired quality, and 4 or 5 a slight or pronounced excess. The score panel was composed of 30 judges chosen from a group of 45 members who had been screened to determine individual preference for very mild, moderate, or pronounced aging in country-style hams. Ten members from each preference level were used in order to obtain the balanced viewpoint necessary for interpretation of comparative scores for hams with widely varying degrees of aging.

RESULTS AND DISCUSSION

Weight losses and reduction in moisture content of lean. Loss of weight was caused largely by reduction of moisture content, but there was some fat (amount not determined) in the drippings from hams stored at 68° and 86° F. As shown in Table 1, loss of moisture and reduction in weight were generally proportional to storage time and temperature. Losses were negligible at 0°, and there was little difference in losses

[a] R. D. Haynes of the Tennessee Valley Authority, currently with Monsanto Chemical Company, assisted in planning the work and curing the hams; Ethyl Shelor and Sara Siewert prepared the ham slices for sensory evaluation.

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at 33° and 50° F. From 10-15% loss, depending on temperature, occurred during the first 3 months, with additional losses of 5-6% during the second period and 4-5% during the last 2 periods.

TABLE 1
Weight losses of stored hams and moisture content of the center lean

Temperature	Time in storage			
° F.	3 months	6 months	9 months	12 months
Weight losses				
	%	%	%	%
0	0.9	0.4	0.5	0.9
33	10.4	15.6	16.7	19.7
50	10.8	16.7	18.2	20.8
68	13.8	20.6	22.4	23.6
86	14.5	20.7	23.1	24.9
Moisture content (65.4% before storage)				
0	66.2	64.6	65.7	66.1
33	60.1	55.9	51.4	49.2
50	59.8	54.0	50.9	48.4
68	56.4	51.4	48.4	43.9
86	53.5	47.4	45.8	38.2

The score panel generally considered the hams dry when moisture fell below 50%, and all except those preferring a pronounced age marked them objectionably dry and hard at moisture levels below 45%. Scores on appearance were also correlated with weight losses, as shrinkage became quite noticeable when it exceeded 20% (see Figure 1).

Figure 1. Two of the 67 hams used in the aging study, after storage for 9 months. The ham stored at 50° F., moderately aged, is lighter in color, less shrunken, and has less surface salt than the ham with pronounced age from 86° F. storage.

As shown later, aging at 33° for 12 months was about comparable to 68° for 3 months, and 50° for 12 months was comparable to 86° for 3 months. In both instances the higher temperatures resulted in about 6% less weight loss for comparable degrees of aging. This is in line with the results reported by Hunt *(6)*, who found 5% less weight loss from hams aged 12 weeks at 108° F. (42.2° C.) than from hams of comparable age which had been stored 12 months at room temperature.

Salt content and the salt: moisture ratio. The salt content of the center lean increased in proportion to temperature up through 68° F., and in proportion to storage time through the sixth to ninth month. These increases were due in large measure to continued penetration or solution of salt into the high-moisture center tissues, but the slight additional increases at 86° F. or after the sixth to ninth month, as shown in Table 2,

TABLE 2
Salt content and salt: moisture ratio in the center lean of stored hams

Temperature	Time in storage			
° F.	3 months	6 months	9 months	12 months
Salt content (2.8% before storage)				
	%	%	%	%
0	3.2	3.8	4.1	4.0
33	5.3	6.5	8.2	8.2
50	5.7	7.5	8.3	8.5
68	6.7	8.2	8.5	9.1
86	6.8	8.8	9.4	10.8
Salt: moisture ratio (.046 before storage)				
0	.049	.057	.063	.062
33	.088	.116	.163	.169
50	.095	.139	.164	.173
68	.118	.159	.172	.208
86	.127	.186	.205	.282

were largely due to concentration of salt through loss of moisture. This point of shift in the predominant mode of concentration represented complete salt equalization from penetration of the curing ingredients.

The panel scores indicated that a salt concentration of approximately 7% in the lean, or a salt: moisture ratio around .130, suited the taste of most of the judges. Some of those who preferred very mild hams scored salt best at around 5-6%, and several of the group liking pronounced age did not object to concentrations up to 9%. As the rate of aging at 33° and 50° was less than the rate of concentration of salt through moisture loss, the best hams were obtained with the shorter periods of storage at 68° or 86°. Growth of mold at relative humidities of 70% and above prevented increasing the humidity to decrease concentration of salt by moisture loss. The only method which appears practical would be the use of less salt in curing hams which are not to be subjected to ambient temperatures; this procedure would resemble the methods currently in use for the production of the "packing house" type of ham, consumed without aging, as discussed by Fields and Dunker *(5)*.

Color. The color of the fat was recorded only in terms of score panel ratings as becoming progressively yellow with increasing time and temperature of storage. The lean exhibited the same trend for red, and the ratings by the score panel were closely correlated with the values for red color determined by comparison with Lovibond standards, as given in Table 3.

In hams held at temperatures above freezing, red accounted for 60-65% of total color units, whereas blue and yellow amounted to 15-20% each. The latter, as background colors, appeared as blue-gray in the hams before storage and in hams stored at 0° and 33°. With aging at the higher temperatures, the blue-gray color was masked by increases in red, resulting in slight brown to purple shades underlying the red in the 9 and 12 month hams at 68° and 86° F.

Shear resistance. Variations in shear resistance were rather large among replicate hams and among different muscle locations in the individual ham slices. Evaluation of the results by analysis of variance *(8)*, however, showed the trends for increase in shear resistance with increases in storage time and temperature to be statistically significant. Mean values for the effects of these factors, and of the muscle positions tested, on resistance to shearing are given in Table 4.

TABLE 3

Blue (B), yellow (Y), and red (R) color of the center lean of stored hams [1]

Time	Color component	Temperature, ° F.				
		0	33	50	68	86
Months		Color units	Color units	Color units	Color units	Color units
3	B	0	0.8	1.2	1.4	2.7
	Y	0	0.8	1.5	1.9	2.3
	R	2.5	2.8	5.4	6.3	7.5
6	B	0.6	1.0	1.4	2.7	3.0
	Y	0.5	1.1	1.5	2.3	2.7
	R	2.9	3.4	5.8	7.5	7.8
9	B	1.0	3.0	3.4	4.2	5.0
	Y	0.7	2.4	3.0	3.5	4.8
	R	4.5	8.7	11.3	11.8	12.4
12	B	1.4	3.2	3.7	4.9	5.4
	Y	2.0	3.1	3.4	3.7	5.4
	R	6.3	9.6	12.1	13.0	13.1

[1] Readings before storage averaged 0.6 B, 0.5 Y, and 2.0 R.

There was no increase in shear resistance in hams stored at 0°. Increases at temperatures above freezing were proportional to time in storage, with a slight trend towards increased toughness at the higher temperatures during the last 6 months of the storage year. The muscles at different positions in the cross section also increased uniformly in shear resistance, with the exception of the semimembranosus (cube 1). This muscle, lying along the exposed cut face of the ham, was rather adversely affected by drying. Whereas the average increases in shear resistance at the temperatures above freezing were 13.0 lbs. in cube 2, 17.1 lbs. in cube 3, and 17.0 lbs. in cube 4 during the 12 months in storage, cube 1 increased 39.1 lbs. in the same period.

Ratings on texture by the score panel generally followed trends in shear resistance, with the exception that those judges preferring hams with pronounced age apparently expected a very firm, dry texture, and hence did not rate the aged hams as being tough.

Peroxide and free fatty acid values. The outside fat of the hams had a very slight odor of rancidity, almost completely masked by the smoke odor, when placed in storage, but sensory rancidity was not observed by the score panel until the sixth month at the two higher temperatures and the ninth to twelfth month at refrigeration temperatures. As seen in Table 5, peroxide values were high and somewhat erratic at the sixth and ninth months, with lower values at the twelfth month. This was considered characteristic for ham fat as the induc-

TABLE 4

Shear resistance of one-inch cubes from the center lean of stored hams

Time	Average shear resistance									
	Temperature, ° F.					Location in ham slice				
Months	0	50	33	68	86	Cube 1	Cube 2	Cube 3	Cube 4	Average
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Before storage	(23.3)	(23.3)	(23.3)	(23.3)	(23.3)	21.7	23.7	30.3	17.3	23.3
3	23.5	27.3	24.8	30.2	29.4	28.5	26.3	34.3	19.1	27.1
6	21.5	34.3	32.0	34.9	34.6	40.5	27.4	34.6	23.4	31.5
9	22.1	38.3	38.2	46.1	39.6	47.7	33.2	39.0	27.5	36.9
12	21.5	43.9	38.1	45.3	51.3	52.7	33.1	44.4	29.9	40.0
Storage average	22.2	36.0	33.3	39.1	38.7	42.4	30.0	38.1	25.0	

TABLE 5

Peroxide numbers and free fatty acids of the external and internal fat of stored hams [1]

Temperature ° F.	Time in storage							
	3 months		6 months		9 months		12 months	
	External	Internal	External	Internal	External	Internal	External	Internal
	Peroxide numbers							
	m-e	m-e	m-e	m-e	m-e	m-e	m-e	m-e
0	17.6	3.4	24.0	21.6	51.5	21.3	18.3	14.0
33	16.6	10.0	64.2	39.9	72.8	36.4	39.4	31.2
50	18.8	8.6	41.2	32.4	71.7	25.7	44.0	30.8
68	20.0	10.6	88.7	63.9	73.7	41.2	71.2	46.6
86	14.0	7.6	47.4	39.1	111.0	48.0	101.8	52.4
	Free fatty acids							
	%	%	%	%	%	%	%	%
0	0.03	0.06	0.12	0.09	0.67	0.71	1.61	1.26
33	0.16	0.11	0.58	0.74	0.78	0.75	2.88	2.94
50	0.19	0.16	1.08	0.79	2.04	1.29	3.60	1.49
68	0.72	0.10	3.69	3.36	6.91	6.39	7.68	6.09
86	4.61	0.58	4.71	1.63	8.52	6.80	9.27	7.70

[1] Values before storage were: for peroxides, 14.8 m-e (milli-equivalents) of O_2 per kilogram of external fat and 6.8 m-e per kilogram of internal fat; for free fatty acids the values were 0.24% and 0.08%, respectively.

tion period proceeded into the period of sensory rancidity, especially at refrigeration temperatures. Analysis of variance indicated questionable significance for the overall effects of the 5 temperatures in accelerating the formation of peroxides, but the effects of storage time and the interaction of temperatures with storage time were quite significant in this respect.

Increases in the free fatty acid content of the fat were proportional to time and temperature. Both free fatty acids and peroxides were uniformly lower in the internal fat, and the values were less erratic, as the internal fat had greater protection from oxygen, bacteria, and other factors which influenced the development of rancidity.

Relative rates of aging. Based on score panel ratings, as illustrated in Figure 2, rates of aging were proportional to storage temperatures at 86°, 68°, and 50° F.

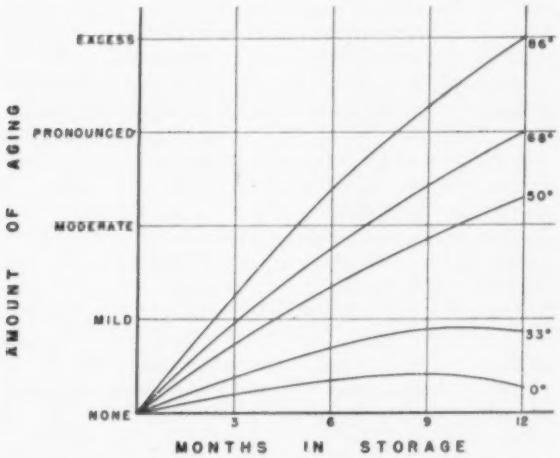

Figure 2. Comparative rates of aging of hams stored at 0°, 33°, 50°, 68°, and 86° F., by sensory panel ratings.

Hams stored at 86° F. were considered typical of mild aging at 3 months, moderate aging at 6 months, and pronounced aging at 9 months. All but 2 of the panel members thought the hams were too "old" at 12 months. Hams stored at 68° F. aged less rapidly, reaching optimum pronounced age at 12 months. While those stored at 50° F. had not reached typical pronounced-age flavor in 12 months, there were no indications of slowing up of the aging process nor of development of foreign or flat flavors.

It seemed doubtful that hams stored at 33° F. would have attained full age had the storage period been extended. The hams began to turn gray in color and to lose flavor between the sixth and ninth months, at which time the degree of aging was still considered under that of a typical mild age. Hams stored at 0° F. remained "fresh" until about the ninth month; from then they also began to turn gray in color and quite bland in flavor, except for the taste of salt.

The comparison of hams stored at 33° and 50° F. was of interest in that although hams at 50° closely paralleled those at 33° in the physical and chemical characteristics studied, they definitely resembled the higher-temperature hams in the development of aged flavor. Hunt and his associates *(6)* noted an acceleration of the proportionate aging rate above 100° F. (37.8° C.). The results obtained in the present study indicate that there may also be a point of deceleration between 50° and 33° F., probably close to 33°.

SUMMARY

Country-style cured hams were stored at 0°, 33°, 50°, 68°, and 86° F. (−17.8°, 0.6°, 10°, 20°, and 30° C.) and examined at intervals of 3 months for a year to compare rates of aging as indicated by weight losses, concentration of salt in the center lean, development of yellow color in the fat and red color in the lean, toughening of the muscle tissues, rancidification of the fat, and development of typical aged flavors. Changes in all these factors, representative of the changes accompanying aging, were proportional to both time and temperature of storage at 50° F. and above. After 12 months hams at 86° were overaged, hams at 68° were fully aged, and those at 50° were moderately aged. Hams stored at 33° F. aged slightly during the first 6 months, remained relatively unchanged during the third period, and then lost desirable color and flavor. Hams stored at 0° F. did not age at all, and the "fresh" color and flavor began to deteriorate after 9 months.

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Effect of Added Calcium Chloride and Sodium Hexametaphosphate (Calgon) on the Pectin Content and Serum Viscosity of Tomato Puree (Pulp)[a]

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(Manuscript received September 19, 1953)

A study was made to determine the effect of added sodium hexametaphosphate (Calgon) and calcium chloride on the relative viscosity and pectin content of tomato puree prepared by the hot and cold break processes. Tomato puree of known raw product quality was manufactured by the conventional hot and cold break processes and by the addition of 0.25% Calgon (by weight) to the tomato macerate prior to extraction by the hot and cold break methods. The various pectic constituents and the relative viscosity (Ostwald-Fenske Viscosimeter) of the tomato serums were determined on all lots of the manufactured puree. In order to determine the effect of the addition of calcium on the relative viscosity of the serum, carefully controlled increments of calcium chloride were added to the clear filterable tomato serum that contained the low methoxyl pectinic acids extracted from the insoluble solids of the puree.

Hot break purees and hot break Calgon purees contained significantly more total pectic substances than purees prepared by the cold break process.

Hot break purees exhibited relative viscosities greater than hot break Calgon, cold break and cold break Calgon purees. All lots of the conventionally processed purees (hot break method) showed a marked decrease in serum viscosity with increased increments of added calcium from 0 to 300 p.p.m. The relative viscosities of hot break Calgon purees increased with increased additions of calcium; maximum serum viscosity values for hot break Calgon purees were obtained for samples receiving 250 p.p.m. added calcium.

The necessity for the inactivation of pectic enzymes has been the one factor most responsible for the introduction of the hot break method of processing tomato juice, puree, and paste *(11, 12, 14)*. Kertesz and Loconti found *(6)* that a product of more pleasing consistency and one that does not settle out can be produced by the hot breaking of tomatoes for juice manufacture. This increase in acceptability is due to the increase in total pectic substances. McColloch and Kertesz *(9)* describe the hot break process as one where the tomatoes are macerated at a temperature in excess of 180° F. (82° C.); and cold break to be any process where the tomatoes are macerated at a temperature less than 180° F.

Underwood *(13)* after conducting extensive studies regarding the consistency and overall quality of commercial tomato paste prepared by 12 different California processors, reported that the consistency of tomato paste varied widely at the same soluble and total solids contents.

McColloch, Keller, and Beavens *(8)* conducted investigations to determine the location of the pectic enzymes in two commercial varieties of tomato fruit. These investigators found up to 70% of the enzymatic activity of Pearson and San Marzano tomatoes was located in the skin and outer portion of the fruit. They pre-supposed that due to the rapidity of enzymic activity even the most efficient hot break processes were unable to retain the bulk of the pectic substances found in the whole fruit *(10)* and that possibly a steam or hot water scald of the whole fruit prior to maceration and preheating would reduce enzymic hydrolysis sufficiently to increase the retention of pectic substances considerably. The results of these investigations indicate that approximately 55% more natural pectic substances may be retained by steam scalding tomato fruit prior to maceration and preheating for paste manufacture.

In recent years, due to the increased importance placed on retention of natural pectic substances, the use of polyphosphates during fruit extraction has been considered. For years manufacturers have noted the detrimental effect of hard water in the commercial processing of many vegetables and in the commercial extraction of pectin *(3)*. It has been proposed that jelly making could be aided by using polyphosphates during the extraction of fruit products for jelly manufacture *(1)*. These investigators *(1)* reported approximately 80% more pectin extracted from blackberries through the use of polyphosphates.

Baker and Gilligan *(2)* state that due to the calcium sequestering ability of polyphosphates, greater quantities of pectin can be extracted from tomato macerates if small amounts of polyphosphates are added prior to extraction. These authors report increased serum viscosities of tomato juice extracted with polyphosphates in amounts up to 1.0%. They also found the greater the hydrogen ion concentration, the more pectin that could be extracted with polyphosphate treatment. Baker and Gilligan *(2)* conclude their studies by stating that in tomato products where a thick viscous consistency is desirable, the use of polyphosphates will cause the extraction of about twice as much pectin as in their absence.

EXPERIMENTAL

During the 1952 growing season, Rutgers variety tomatoes were grown at the Ohio State University Horticultural farm at Columbus, Ohio. The ripe tomatoes were harvested weekly starting August 21st and continuing through the first week of October.

Processing. The raw tomatoes used in the preparation of experimental lots of puree were graded by a U. S. Department of Agriculture raw products inspector; they were composed of a known maturity classification of 50% U. S. No. 1's and 50% U. S. No. 2's as determined by color. The U. S. No. 1 tomatoes

[a] Presented at the Thirteenth Annual Meeting of the IFT, Boston, Massachusetts, June 22, 1953.

contained 90% or better tomato red color; the U. S. No. 2's contained 66⅔% or better tomato red color.

Cold break (7 replications). The washed whole tomatoes were extracted through a 0.023" extractor screen and the waste finished or re-extracted through a .023 pulper screen. The extracts were combined and concentrated to 12% soluble solids in a steam jacketed open kettle, filled into No. 2 plain tin cans, sealed using a 10 p.s.i. steam flow closure and allowed to air cool.

Hot break (5 replications). Following washing, the tomatoes were macerated through a one-half inch screen, and then immediately preheated in excess of 180° F. (82° C.) in a stainless steel tubular heat exchanger and pulped through a 0.023" screen. Following extraction, the hot break juice was concentrated, filled, sealed, and cooled the same as for cold break puree.

Cold break Calgon (1 replication). This process differed from the conventional cold break method in that the washed tomatoes were macerated through a one-half inch screen and 0.25% Calgon added to the comminuted product which was subsequently pulped through a 0.023" screen; the remaining steps of the process were the same as for the other methods.

Hot break Calgon (2 replications). Twenty-five hundredths percent Calgon[b] by weight was added to the freshly macerated tomato tissue prior to preheating; the subsequent steps of the hot break Calgon process were identical to the conventional hot break process.

Pectin analysis. All the samples of puree were analyzed in order to determine the content of the various pectic solubility fractions according to a modification of the method outlined by McColloch *(7)*.

Extraction of various pectic substances:

(a) *Water-soluble extract.* Approximately 10 g. of well mixed tomato puree were accurately weighed and transferred to a 125 ml. Erlenmeyer flask with 30 ml. of distilled water and allowed to extract for 2 hours at 30° C. with frequent agitation. Following extraction the mixture was filtered, saving the supernatant, and the water extraction of the insoluble residue repeated. The combined filtrates contained the "water soluble" pectic substances.

(b) *"Oxalate-soluble" extract.* The insoluble residue from the second water extraction was washed into the extraction flask with 30 ml. of 0.2% ammonium oxalate solution. Two 2-hour extractions were made at 30° C. and the combined filtrates contained the "Oxalate-soluble" pectic substances.

(c) *"Acid-soluble" extract.* The insoluble residue from the second oxalate extraction was washed into the extraction flask with 30 ml. of 0.05 N. HCl. Two extractions of 2 hours each were carried out as described above except the temperature was maintained at 80° C. and the combined filtrates contained the "acid-soluble" pectic substances.

In order to preserve the preparations of the various solubility fractions for future analyses, the pectic substances were precipitated from 60% ethanol (accomplished by the addition of 95% ethanol acidulated to 0.05 N. with HCl), and the samples tightly stoppered and stored at 5° C.

Determination of methoxyl content and percentage calcium pectate:

A modification of the calcium pectate method described by Hinton *(5)* whereby methoxyl content and percentage calcium pectate are determined simultanously was used in this study; following is a description of the method of pectin analysis employed.

The ethanol precipitate obtained for each of the various solubility fractions was washed 3 times with 60% ethanol and transferred to a 600 ml. beaker and dissolved in 250 ml. of distilled water. Using an electric titrimeter, the free acidity of the pectin dispersion was carefully neutralized to an end point of pH 7.5 using 0.05 N. NaOH, then an accurately measured excess of 10 ml. of 0.5 N. NaOH was added in order to completely saponify all methyl groups; the mixture was agitated vigorously and allowed to stand at room temperature for a period of at least one hour. Following saponification, the excess alkali was back titrated with 0.1 N. HCl. A blank determination of 100 ml. distilled water was treated the same as the analytical samples and the difference between the amount of HCl required for the back titration of the blank and the analytical samples is equivalent to the base consumed in the saponification of the acidic groups that were methyl esters before addition of the base. The results are expressed as percent methoxyl.

Following the back titration for methoxyl groups, 50 ml. of 1.0 N. acetic acid were added and the mixture allowed to stand for 10 minutes. First 20 ml. of 0.1 M. $CaCl_2$ followed by 20 ml. of 2 M. Ca Cl_2 were added with vigorous stirring. The solution was rapidly heated to a rolling boil at which time heating was continued for 2 minutes longer in order to bring about complete precipitation of calcium pectate; the precipitate was collected on a hard, fast filtering sharkskin filter paper and washed 4 times with boiling water. The precipitate was then washed back into the beaker with no more than 200 ml. of distilled water and brought to a boil again; after boiling for 2 minutes the precipitate was collected on a previously washed, dried and weighed sharkskin filter paper. The calcium pectate was repeatedly washed with boiling distilled water until the filtrate gave a negative test for the presence of chlorides as evidenced by treatment with silver nitrate. The filter paper containing the calcium pectate was dried at 100° C. for 6 hours, cooled, weighed and results expressed as g. of calcium pectate per 100 g. of tomato puree.

Measurement of serum viscosity. Viscosity is the resistance offered to flow by a fluid or solution and is a characteristic property of colloids such as pectin when dispersed in water.

During this study the serum viscosity values obtained for experimental purees were expressed as "relative viscosity" which is obtained by comparing the viscosity of the test solution with the viscosity of water.

Capillary viscosity measurements were made on the clear filterable serum on all samples of tomato puree using an Ostwald-Fenske Viscosimeter. (All samples, standard solutions, distilled water and viscosimeters were kept at 25° C. in a constant temperature water bath.) In order to better determine the true relationship that exists between pectic substances, added calcium and serum viscosity, the pulpy insoluble mass of tomato tissue that was retained on the filter paper following separation of the tomato serum, was extracted with a volume of 0.2% ammonium oxalate solution equal to the original volume of puree. The low methoxyl pectin (pectinic acids) contained in the oxalate extracts were precipitated from 60% ethanol, filtered off, washed, dried and dissolved in the original tomato serum. Carefully controlled increments of calcium (as calcium chloride) were added to the tomato serums thus prepared and the viscosimetric measurements made after 10 minutes and again after 4 hours; the values thus obtained were averaged for each sample and expressed as relative viscosity.

RESULTS AND DISCUSSION

Inspection of the graphic presentation of the calcium-pectate analysis, Figure 1, clearly shows the hot break and hot break Calgon samples to contain significantly

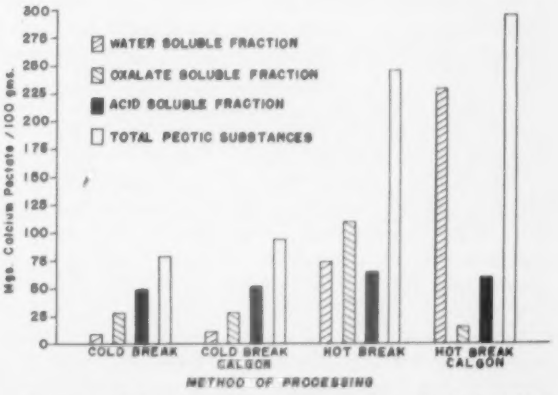

Figure 1. Effect of process on the pectin content of various pectic solubility fractions of tomato puree (from raw stock consisting of 50% No. 1's and 50% No. 2's).

[b] Unadjusted sodium hexametaphosphate procured from the Calgon Corp., Pittsburgh, Pa.

more total pectic substances than the purees prepared by the cold break methods. The difference that was found to exist between hot break samples (0.2461 g. calcium pectate/100 g.) and hot break Calgon samples (0.2941 g. calcium pectate/100 g.) is statistically significant at the 1% level. It is to be noted when considering the conventionally processed hot break samples, the low methoxyl pectins (oxalate-soluble fraction) make up the bulk of the soluble pectic substances. Due to the calcium sequestering action of Calgon, the pectinic acids that are water insoluble in the presence of calcium, became water soluble in the presence of Calgon; thus the water-soluble fraction of the hot break Calgon purees contained 95% of the soluble pectic substances.

Close inspection of Figure 1 shows only 10% more total pectic substances were found in the cold break Calgon sample (0.0942 g. calcium pectate/100 g.) when compared with the conventional cold break purees (0.0857 g. calcium pectate/100 g.). This difference becomes insignificant when compared with hot break and hot break Calgon samples which on an average contained 185% and 240% more total pectic substances respectively than the samples prepared by the cold break method.

Table 1 shows the variation in methoxyl content, as determined by saponification, of the various solubility fractions of tomato puree prepared by different methods of process.

TABLE 1

Methoxyl content of various solubility fractions of tomato puree as determined by saponification

Process	Percent methoxyl on a calcium pectate basis		
	Water soluble fraction	Oxalate soluble fraction	Acid soluble fraction
Cold break	(a)[1]	4.31	4.88
Cold break Calgon	6.07	4.07	5.71
Hot break	9.11	3.98	5.18
Hot break Calgon	5.88	(a)[1]	5.44

[1] Insufficient amount of pectic substances in these fractions to permit accurate methoxyl determinations.

The average value obtained for the water soluble fraction of the hot break Calgon samples (5.88%) is considerably lower than the average value obtained for the corresponding hot break samples and can be explained by the presence of the low methoxyl pectins in the water-soluble fraction of the Calgon treated samples due to the calcium sequestering action of sodium hexametaphosphate.

Figure 2 is presented to show the effect of added increments of calcium on the serum viscosity of the clear filterable serum of tomato puree. The curves presented in Figure 2 are lines of "best fit" and clearly illustrate the effect of added ionic calcium on the relative viscosity of pectinate dispersions. No significant effect was recorded for the cold break and cold break Calgon samples undoubtedly due to relatively low pectic substance content of these samples. When considering the conventional hot break samples, added increments of calcium brought about slight increases in relative viscosity, followed by marked decreases at the more concentrated calcium levels. The hot break Calgon samples exhibited marked increases in relative viscosity at 200 and 250 p.p.m. calcium; maximum serum viscosities for hot break Calgon samples were obtained for puree serums receiving 250 p.p.m. added calcium.

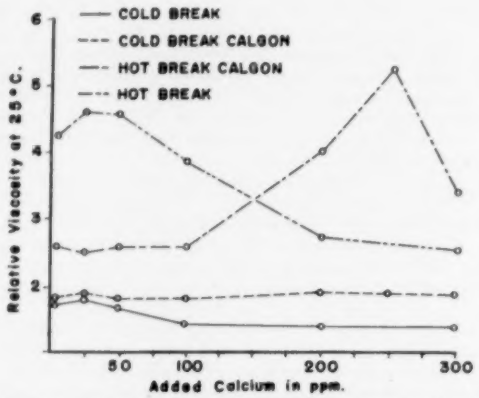

Figure 2. Effect of process and added increments of calcium on serum viscosity of tomato puree (from raw stock consisting of 50% No. 1's and 50% No. 2's).

SUMMARY AND CONCLUSIONS

Purees prepared by the hot break Calgon process contained significantly more total pectic substances (23% more than comparable hot break samples) than purees prepared by the conventional methods of processing. However, the Calgon treated lots exhibited serum viscosities significantly lower than those obtained for the purees prepared by the conventional hot break process.

The addition of calcium to the clear filterable tomato serum of all samples of puree (hot break samples) prepared from Rutgers variety tomatoes, resulted in startling changes in relative viscosity. The purees prepared by the conventional hot break method (preheated to 180° F.) showed a marked decrease in serum viscosity with increased increments of added calcium; insignificant differences were observed for the cold break and cold break Calgon samples. The relative viscosities of the filterable serum of the hot break Calgon purees showed an increase of 98% over the 0 calcium treatment with 250 p.p.m. added calcium.

Since the Calgon treated lots exhibited increases and conventionally processed lots exhibited decreases in relative viscosity with added increments of calcium, the importance of the relationship of low methoxyl pectin to calcium content as it influences serum viscosity of tomato puree becomes evident. The calcium chelating effect displayed by Calgon coupled with the fact that the pectins of purees analyzed were found to be predominately low methoxyl, helps to account for the discrepancies found when comparing pectin content and serum viscosity for purees prepared by the hot break and hot break Calgon processes.

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Carbohydrate Changes During Storage and Cooking of Sweet Potatoes

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The effect of original sugar content upon cooked sweet potatoes after storage is described. Starch-sugar changes are followed through the cooking process to determine the influence of various methods of precooking and cooking upon total sugar content. Methods of evaluating the cooking properties of present varieties of sweet potatoes are described. Baking is shown to be the most important factor influencing the final quality of the sweet potato and is recommended as a performance factor to consider in sweet potato breeding programs.

The sweet potato *(Ipomoea batatas)* ranks high in commercial value and importance as a vegetable crop in the United States. Since the sweet potato is a warm season crop, it must be grown in a relatively short period during the year, and if this vegetable is to remain on the table for the entire year, it must be stored under ideal conditions or preserved in some way. Much work has been done on determining storage temperatures best adapted to the storage of different sweet potato varieties *(4, 7, 9)*.

Varieties differ in starch-sugar changes during storage at different temperatures, but generally low temperatures cause an accumulation of sucrose in fresh potatoes. Temperatures below 55° F. cause a breakdown of the sweet potato during prolonged storage, the breakdown occurring more rapidly as the temperature is lowered toward freezing *(9, 10)*.

The table varieties of sweet potatoes grown in Louisiana vary in total sugar content at harvest time, depending upon the time of harvest and the growing conditions *(14)*. One of the purposes of this study was to determine the effect this original sugar content had upon the cooked product after storage.

Another purpose was to follow the starch-sugar changes through the cooking process to ascertain the effects of various methods of precooking and cooking upon the total sugar content in sweet potatoes.

Little is known of the variations in total sugars, starch, specific gravity, and total solids within a variety of sweet potatoes and how these components react to cooking after storage. With these different factors in mind, the purpose of this study was to search for ways of evaluating and improving the cooking ability of our present varieties of sweet potatoes and to point out new factors to consider in a sweet potato breeding program.

REVIEW OF LITERATURE

Sweet potatoes apparently remain low in sugar content during the growing season. After harvest and storage at high temperatures the conversion of starch to sugar is rapid at first, but it slows down to an equilibrium state. Slower rates of conversion prevail at low temperatures and the equilibrium point is shifted so that a greater accumulation of sugars is possible. Evidently, hydrolysis of starch in the sweet potato results in the formation of reducing sugar, and sucrose is synthesized from the reducing sugar *(7)*. Dextrose, levulose and sucrose are thought to be the principal sugars present in the fresh sweet potato *(12)*.

When sweet potatoes are stored at low temperatures, the reducing sugar content decreases which seems to indicate that starch is converted to reducing sugars and then to sucrose. Also, total sugar content increases at 6 to 7° C. to a greater extent than at 12 to 30° C. *(7)*.

In specific storage temperature tests by Hopkins and Phillips *(9)* both cured and uncured roots were stored at 50, 55, 60, 65, and 70° F. The sucrose content increased from 2.5% in freshly dug potatoes to 3.3% after curing, in the Triumph variety. In the uncured lots, sucrose content increased from the beginning of storage at 50 and 55° F., but at 60, 65, and 70° F. the increases reached a maximum at 12, 20, and 10 days respectively, then it began to decrease. As the temperature decreased, the maximum sugar content attained was higher and the decline was not so sharp during prolonged storage. The data obtained showed a wide difference in sugar accumulation in potatoes stored at 55 and 60° F. This is reflected in both cured and uncured lots, which indicates the existence of a critical temperature as in the storage of Irish potatoes between 35 and 40° F.

Experiments with the Porto Rican variety showed that when potatoes are exposed to 40° F. for one week internal breakdown usually occurs. Lower temperatures, down to 30° F., gave similar results *(10)*.

Changes in the amounts of sucrose in sweet potatoes are sometimes taken as a measure of the rate of starch degradation at different temperatures *(9)*. Judging by the pattern of change during curing starch quality is apparently modified by changes in the starch granule diameter, density, water holding capacity, and substances absorbed within the granule *(2)*. The rate of gelatinization of starch was found to be governed by the diameter of the granule and its density. Indirectly, the gelatinization rate was affected by the water holding capacity, amount of organic substances present, and the alkali lability *(2)*.

There is a transformation of starch to dextrin and sucrose during the storage of sweet potatoes *(4)*. Some of the starch splits to form maltose during the cooking process *(4, 5)*.

The ratio of starch to moisture largely determines the consistency of the sweet potato. The chief factor causing the difference in sweetness of cooked sweet potatoes is the amount of sucrose formed in storage. Apparently, there is no change in sucrose content during cooking, but rather during curing and storage *(4)*.

Since maltose arises from the conversion of starch during cooking, this greatly affects the softness of the cooked product, although the degree of sweet potato softness is not proportional to the amount of maltose present *(4)*.

Sweet potatoes are reported to be rich in diastase which when present in very small quantities may convert practically all of the starch to reducing sugar during the cooking process *(6)*.

There is evidence that indicates that temperature alone has some effect on sugar conversion in sweet potato slurry. A portion of the sugar present may be a direct heat effect, since sugar is formed when slurry is added directly to boiling water. Normally, boiling temperatures are expected to inactivate proteinaceous enzymes, although enzymes may have prepared a portion of the starch for auto-conversion to sugar before boiling *(11)*.

Work with Unit I Porto Rico variety in relation to specific gravity indicated that the higher the dry matter content the higher the specific gravity. Also, the high-specific gravity potatoes showed a greater amount of darkening after baking *(8)*.

A considerable amount of research has been carried out on the carbohydrate changes during storage with special emphasis on accumulation of sucrose at the lower temperature, but these changes have not been followed through the baking and cooking process. Also, varietal differences during storage and cooking have not been noted. One factor that has been stressed in breeding sweet potatoes for superior lines is the high total sugars found in the fresh roots at harvest. This point led the authors to investigate the value of a high sugar content at harvest and to attempt to evaluate the quality of some of the varieties by their carbohydrate changes during storage and baking.

EXPERIMENTAL PROCEDURES

The *2* lots of sweet potatoes for these tests were grown in North Louisiana and at Baton Rouge, Louisiana. They were harvested in October, 1952, and stored in common storage. After *2* weeks of storage the 3 varieties listed in Table 1 were sampled and moved into a constant temperature storage room at 60° F.

The fresh samples were analyzed, using 12 potatoes per sample. Four potatoes of each of these varieties were baked in a 350° F. oven for 75 minutes, cooled in open air, peeled, and mashed for analyses.

Total solids determinations consisted of weighing 10 g. samples into tin boxes and drying at 70° C. for 24 hours. Sugar contents were measured by the colorimetric ferricyanide method for reducing sugars *(13)*. Starch analyses were run by the direct acid hydrolysis method *(1)*.

Seedlings and varieties, listed in Table 2, were stored in common storage 6 weeks before analyses were made. After 2 months of storage at 60° F. specific gravity determinations were made on the Unit I Porto Rico variety. A mixture of ethyl alcohol and water was adjusted to the various specific gravity values shown in Table 3 by hydrometer at 60° F. The sweet potatoes that floated at the various specific gravity levels were designated as being at that level. Other analyses were made by the same procedure as on previous samples.

Processing of the treated samples shown in Table 4 was carried out in a laboratory-size pressure cooker. Potatoes in all treatments were peeled by paring and processed in No. 2 tin cans except those in the baked sample.

DISCUSSION OF RESULTS

Variety storage test. The total sugar contents at the time of harvest of the 3 varieties listed in Table 1 were not appreciably different. After curing Unit I Porto Rico was higher than the other varieties in reducing sugar content in the fresh samples and remained that way throughout the storage period. However, both Goldrush and Earlyport accumulated more total sugars during the storage period than Unit I Porto Rico, which indicates varying responses to different temperature storage among the varieties. Goldrush accumulated more total sugars in storage than Earlyport and slightly more reducing sugars in the fresh samples, but in the cooked product Earlyport contained a higher percentage of reducing sugars than Goldrush in all instances. Unit I Porto Rico remained relatively low in total sugar content throughout the storage period, and apparently the slight gain was due to higher reducing sugars present; however, during the cooking process Unit I Porto Rico converted a great deal more starch to reducing sugars than either of the other varieties.

The higher starch content of Earlyport in the cooked samples possibly accounts for its having a firmer texture than either of the other varieties. Also, the low starch

TABLE 1

Changes in the sugar content of three varieties of sweet potatoes after curing and storing at 60° F. storage

Variety	% Total solids	% Reducing sugars	% Non-reducing sugars	% Total sugars		% Starch
				Fresh wt.	Dry wt.	
October (At harvest)						
Unit I	29.63	.69	3.87	4.56	15.39	.....
Goldrush	27.04	.56	3.56	4.12	15.24	.....
Earlyport	29.78	.46	3.02	3.48	11.68	.....
November—Fresh (2 weeks after harvest)						
Unit I	30.29	0.65	4.98	5.63	18.59	.....
Goldrush	26.81	0.47	5.04	5.51	20.55	.....
Earlyport	29.30	0.36	4.57	4.93	16.83	.....
November—Cooked [1]						
Unit I	32.91	10.40	6.71	17.11	51.99	4.21
Goldrush	30.98	7.51	8.55	16.06	51.84	4.73
Earlyport	32.28	9.48	7.37	16.85	52.20	5.27
January—Fresh (2 months' storage)						
Unit I	32.11	0.79	5.39	6.18	19.25	.....
Goldrush	29.45	0.68	6.42	7.10	24.11	.....
Earlyport	33.36	0.59	6.28	6.87	20.59	.....
January—Cooked						
Unit I	37.72	17.13	6.62	23.75	62.96	3.67
Goldrush	32.78	12.30	7.57	19.87	60.62	3.62
Earlyport	35.21	14.22	7.32	21.54	61.18	4.59
June—Fresh (7 months' storage)						
Unit I	32.29	1.72	4.26	5.98	18.52	.....
Goldrush	28.81	1.58	6.83	8.41	29.19	.....
Earlyport	31.34	1.39	5.39	6.78	21.63	.....
June—Cooked						
Unit I Porto Rico	37.16	14.44	6.44	20.88	56.19	4.14
Goldrush	33.52	10.29	7.66	17.95	53.55	3.05
Earlyport	35.61	10.59	7.36	17.95	50.41	4.84

[1] Baked in oven for 75 mins. at 350° F.

content of Goldrush cooked in June along with the lower total solids, which is typical of this variety, may be responsible for its softness. These data point out new facts to consider in breeding a sweet potato for fresh shipment, canning, and storage.

Varietal differences. There are extreme differences in the carbohydrate contents of the different varieties of sweet potatoes grown in Louisiana. High moisture content appears to influence the accumulation of total sugars in storage, as indicated by the Heartogold variety. This is shown in Table 2. Although this variety

TABLE 2

A comparison of some of the varieties and seedlings as to baking[1] quality by their sugar content after six weeks in common storage

Variety	% Total solids	% Reducing sugars	% Non-reducing sugars	% Total sugars		% Starch
				Fresh	Dry	
Unit I	32.91	10.40	6.71	17.11	51.99	4.21
Goldrush	30.98	7.51	8.55	16.06	51.84	4.73
Earlyport	32.28	9.48	7.37	16.85	52.20	5.27
0-123	32.96	7.85	9.19	17.04	51.70	4.26
Heartogold	26.92	4.74	10.04	14.78	54.90	3.82
Allgold	29.46	6.49	9.27	15.76	53.50	3.55
Queen Mary	28.80	7.34	5.63	12.97	45.03	5.02

[1] Potatoes baked 75 minutes at 350° F.

accumulated almost twice as much non-reducing sugars during storage as Unit I Porto Rico when cooked it contained much less total sugars on a fresh basis; however, on a dry weight basis this did not hold true. The percent total solids in the fresh potato apparently influences the level of total sugar content attained during the cooking process since there is not a great deal of moisture loss during baking. These varieties of sweet potatoes lost from 2 to 5% during baking without wrapping. There appears to be no differences in total sugar content in any of the varieties when they are compared on a dry weight basis except in the Queen Mary variety.

The Unit I Porto Rico variety converted a higher percentage of reducing sugars during baking than any of the other varieties. This could account for the smooth texture of this variety after baking. Also, the higher starch contents found in part of the varieties after baking may be responsible for their firmer texture, as pointed out by other authors working with freshly dug sweet potatoes *(3)*.

The samples shown in Table 2 were not analyzed in the fresh state because of the limited amount of the sample. Therefore, the non-reducing sugar contents are slightly higher than would be found in the fresh samples due to slight loss in moisture during baking, loss from heat, and experimental error. Other authors have also pointed out that there is little or no change in non-reducing sugars during cooking *(4)*.

Specific gravity differences within a variety. Specific gravity studies with the Unit I Porto Rico variety after 2 months of storage indicate that the higher the specific gravity the higher the total solids after baking, although the percent total solids varied somewhat in the fresh potatoes (Table 3). Since different potatoes had to be used for the fresh sample analyses this may account for the differences exhibited. It was

TABLE 3

Analysis of various specific gravity levels in relation to total solids, sugars, and starch content of Unit I Porto Rico variety after 2 months of storage

Specific gravity	% Total solids	% Reducing sugars	% Non-reducing sugars	% Total sugars	% Starch	
0.950	31.78	0.90	5.19	6.09	.....	raw
	36.67	16.70	6.19	22.89	4.83	cooked[1]
0.970	32.52	0.90	4.97	5.87	.....	raw
	36.19	15.82	6.17	21.99	3.81	cooked
0.985	35.12	0.70	3.91	4.61	.....	raw
	36.21	16.70	7.99	24.69	3.03	cooked
0.992	30.67	0.80	6.23	7.03	.....	raw
	36.54	17.38	5.30	22.68	3.43	cooked
0.997	30.55	0.70	5.90	6.60	.....	raw
	38.52	17.18	6.16	23.34	3.43	cooked
1.000	30.19	0.70	7.08	7.78	.....	raw
	40.24	17.88	6.99	24.87	3.81	cooked
1.017	33.95	0.80	4.45	5.25	.....	raw
	39.65	18.22	7.55	25.77	3.36	cooked

[1] Baked 75 minutes in 350° F. oven.

observed that the higher the specific gravity the higher the reducing sugars after baking. This is a significant factor in this study since it correlates very well with the amount of darkening in the samples on standing in the open air. The total sugars, except for sample variability, seemed to follow this same pattern; however, the percent total sugars in the fresh potatoes appeared to have little effect on the percent total sugars in the cooked product.

There appeared to be only small differences in the reducing sugar content in the fresh samples. Also, the lower the specific gravity, the higher the starch content remained after baking. No flavor differences could be detected in the samples although the color varied due to darkening.

Effect of method of handling on the total sugar content in canned sweet potatoes. Information has been distributed in the canning industry concerning pre-heating and its effects on the increase of total sugars in processed sweet potatoes *(14)*. This test was triplicated in an attempt to avoid error in samples and procedures, and the results were averaged and compiled on Table 4.

Exhausting was carried out in water in order to simulate the method used in canning syrup-pack sweet potatoes. After treatment these samples were processed dry-pack to avoid any confusion by addition of liquids. Note the loss of sugars in the pre-heating process. This loss is not recovered in the can, although where the potatoes are exhausted in a syrup-filled can the leached sugar remains in the product. Apparently, there was as much total sugars present in potatoes packed raw in the can as in any other treatment. In fact, on a dry weight basis, this sample was the highest in total sugar content. There was a slight loss of sugars in baking as shown on the dry weight basis.

Apparently pre-heating does not increase the total sugar content in canned sweet potatoes. It does speed up the peeling operation and makes it more uniform. Also, it seems to help in gelatinizing the starch during lye- or steam-peeling and results in a more transparent color of potatoes after peeling *(3)*. It seems that a potato will convert a certain amount of sugar during

TABLE 4

Effect of method of treatment and cooking upon the sugar conversion of the Porto Rican sweet potato

Treatment	Process	Percent sugar in treatment water	Percent dry matter	Percent sugar in final product	Total sugars	Percent sugar dry basis
1. Heated unpeeled at 175° F. for 30 minutes	45 min. at 240° F.	1.83	29.63	14.66	16.49	55.65
2. Regular exhaust to 185° F. in water	45 min. at 240° F.	2.46	31.14	15.11	17.57	56.42
3. Same as No. 1 except 160° F.	45 min. at 240° F.	1.83	31.58	15.55	17.38	55.03
4. Check, packed raw in cans	45 min. at 240° F.	.....	30.07	17.06	17.06	56.73
5. Baked in oven 75 min. at 350° F.	None	.....	34.66	17.90	17.90	51.64

the normal processing operation regardless of what method is employed.

Storage temperatures and sugar changes. In order to point out the variation in sugar content at different temperatures within a variety, Unit I Porto Rico was analyzed after seven months of storage at various storage temperatures. The results, presented in Table 5,

TABLE 5

Differences in sugar content of Unit I Porto Rico variety after seven months of storage at various temperatures

Storage temperatures	Total solids	Reducing sugars	Non-reducing sugars	Total sugars	
				Fresh wt.	Dry wt.
Common storage	30.00	1.30	5.65	6.95	23.17
50° F.	27.08	1.30	11.05	12.35	45.61
60° F.	27.47	1.65	5.70	7.35	26.76
Common to 60° [1]	28.14	1.58	5.52	7.10	25.23

[1] Moved from common to 60° storage after two months.

show that the reducing sugars are lower at common and 50° F. storage than at 60° F. or common-to-60° F. storages. There was apparently no difference in total sugars in common, 60° F., or common-to-60° F. storages on a fresh weight basis, but a marked difference occurred in the 50° F. storage on both fresh and dry weight bases. The common storage sample is somewhat lower in total sugars on a dry weight basis. There appears to be a critical temperature point between 50° F. and 60° F., as pointed out by other investigators *(7, 9)*.

SUMMARY

The effects of variety, specific gravity, total solids, cooking, and storage temperature on carbohydrate changes in sweet potatoes were investigated.

Baking was the most important factor influencing the final quality of the sweet potato. Although definite changes did occur during storage within a variety and between varieties the results after baking appeared to be the best criterion to use in selecting for quality. This is one important factor which is minimized in most sweet potato breeding programs.

The amount of sugar accumulated during storage was not an indication of what could be expected in the cooked product. Also, total solids directly influenced the total sugar content after cooking in most varieties. This points out the fact that in evaluating seedlings for possible new varieties, high total solids content and good cooking ability may well be the key to the origination of better varieties.

The 60° F. storage temperature had its effect on carbohydrate changes in the varieties Unit I Porto Rico, Goldrush, and Earlyport. There was an increase in the reducing sugar content in all varieties throughout the storage period. Also, an accumulation of total sugar content occurred, being markedly higher in Goldrush than the other varieties.

Specific gravity variations within a variety are largely due to variations in sugar content. After baking the high specific gravity level samples contained the highest amounts of reducing sugars, total sugars, and one of the lowest amounts of starch.

Sweet potatoes packed raw in the cans and processed contained as much total sugars in the final product as those pre-heated in water or exhausted prior to processing.

There appears to be a lower reducing sugar content in the Unit I Porto Rico variety when stored at common or 50° F. storage than at 60° F. storage. Storage at 50° F. resulted in the highest accumulation of total sugars on both the fresh and dry weight bases.

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Flavor and Color Evaluation of Canning Crops Grown on Soil Treated with Insecticides[a]

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The effect of soil insecticides on vegetables grown on land thus treated was investigated. This study reports results of one year's tests on the harvest from test plots treated with selected insecticides, applied in various amounts per acre. Taste tests and color comparisons were made. No characteristic off-flavor could be definitely ascribed to an insecticide but some indication of color changes appeared to be related to the soil treatments.

The rapid increase in the use of chlorinated hydrocarbon insecticides for the control of soil-inhabiting insects, such as wireworms, has been noted with some alarm by the vegetable processors of New York. Land previously treated with these insecticides is regarded by canners as having potential hazards, and at present they will not accept crops grown on such land. Knowledge of the absorption of pesticidal substances by vegetables grown in insecticide-treated soil or their effect on flavor and color is inadequate at this time. This paper reports the first year's tests of methods of growing and processing vegetables on control plots and plots treated with chlorinated hydrocarbon insecticides, methods and results of taste tests, and color comparisons.

GROWING AND PROCESSING

An exploratory experiment was conducted in 1952 in order to obtain some basis for future investigation of the soil insecticide problem. Upland soil was treated with 4 insecticides: aldrin at 4 and 8 pounds, chlordane at 5 and 10, dieldrin at 3 and 6, and DDT at 50 pounds per acre. Treatments were applied as sprays to the soil surface and then thoroughly mixed into the top 4-6 inches by means of a spring-toothed harrow. Wettable powder formulations were used in all cases in order to eliminate any possible flavor effects that might be attributable to the solvents used in emulsifiable concentrates. Six canning crops—peas, snap beans, beets, carrots, squash, and tomatoes—which might normally be grown in this area as succession crops were planted in the plots. Treatments were randomized from east to west and crops from south to north. Plots were 35′ x 50′. Samples were obtained by harvesting the whole plot with the exception of buffer areas between treatments. In the case of squash only one fruit per plant was sampled, or 3 per hill. The spinach samples were obtained from a replicated experiment conducted on muck land. Heptachlor applied at the rate of 3 and 6 pounds per acre was substituted for DDT. A one-bushel sample of spinach was obtained from each replicate and the 4 bushels blended into a single sample.

The harvested crops were processed into purees and packed in 4-oz. glass jars in the pilot plant of a commercial processor,[b] except tomatoes which were made into tomato juice in the Station pilot plant. Each pureed sample was made as a single batch in a steam-jacketed open kettle and precooked with a steam injection pipe. Samples were sieved, bottled, vacuum capped, and cooked in a retort. The crops were processed as a water pack containing no additives or seasoning. Times and temperatures for the processing are given in Table 1. The tomatoes were processed in a continuous process line, being preheated to 190° F., flash pasteurized at 250° F. for 0.7 minute, canned in No. 2 cans at 200° F. and held for 3 minutes before cooling. Fifty g. of $NaCl_2$ were added to each No. 2 can of juice. All samples were stored in the dark at 70° F. until used. Color evaluations on carrots and squash were made after 4 months' storage, while flavor tests were conducted through a storage period of 2-6 months.

TABLE 1

Processing times and temperatures of vegetables grown on treated soil

Crop	Precook		Cook	
	Time minutes	Temp. ° F.	Time minutes	Temp. ° F.
Squash	10	200	50	240
Carrots	10	200	45	243
Peas	10	200	50	243
Beans	10	200	45	243
Spinach	5	200	50	240
Beets	10	200	45	243

Sensory Flavor Tests

The pureed vegetables, packed in 4-oz. glass jars prepared from vegetables grown on treated and untreated soils, were compared in flavor tests to determine what effect, if any, these soil treatments had on the flavor and color.

After the publication of *Technical Bulletin No. 284* (flavor evaluation procedures) by Hening *(2)*, a taste testing room was set up for this work. A more recent brief description of methods used has been published *(3)*.

The tasters used for this problem are on the staff from the Divisions of Food Science and Entomology. These persons are not selected tasters for a specific product but have had experience in evaluating the flavor of a number of products. Eleven to 24 persons have been used in these tests. Usually 11 to 17 persons are used. If the results are only somewhat significant, the tests are repeated.

The triangle test was selected as a satisfactory means of comparing pureed vegetables from treated and untreated soils. In some cases if this test had not been used, the average scores of the tasters would have shown that there was no difference in the samples from the treated and untreated soils when there really was a significant difference. In some specific cases the tasters paired the like samples with highly significant results, showing that they could distinguish the samples from treated and untreated soils, but sometimes the tasters preferred the flavor of the sample from the treated soil.

The tasters for these tests used the score sheet with a 1-10 scale in which 1 is *extremely poor* and 10 *excellent*. It is actually a 9-point scale since the score 10 was not used. If the tasters can match the like samples, they score them the same and the odd sample higher or lower according to their preference. The percentage of correct selections needed for the various degrees of significance was obtained from a graph presented by Gray, Stone

[a] Journal Paper No. 939, New York State Agricultural Experiment Station, Geneva, N. Y., August 31, 1953.

[b] Clapp's Baby Food Division, American Home Foods, Rochester, N. Y.

TABLE 2

Results of flavor evaluation of pureed vegetables grown on soil treated with various insecticides. Geneva, N. Y., 1952.

Treatment in terms of pounds per acre	Number of tasters	Average scores triangle test			Number of persons who paired like samples preferring		Correct selections percent	Percent correct selections needed for	
					Untreated	Treated		Significant	Highly Significant
Pureed Squash									
Dieldrin, 6 lbs.	24	check 5.4	check 5.3	dieldrin 4.2	10	2	50.0	53.0	.....
Dieldrin, 6 lbs.	16	check 6.3	dieldrin 5.4	dieldrin 5.4	7	3	55.5	57.0	.....
Dieldrin, 3 lbs.	15	check 5.9	check 6.4	dieldrin 5.4	6	0	40.0	57.6	.....
Aldrin, 8 lbs.	17	check 5.9	aldrin 4.6	aldrin 4.8	8	1	53.0	56.7	.....
Aldrin, 4 lbs.	15	check 5.9	aldrin 5.1	aldrin 5.4	7	2	60.0	57.6	.....
Aldrin, 4 lbs.	15	check 6.3	check 6.2	aldrin 4.7	11	0	73.0	57.6	66.0
Chlordane, 10 lbs.	17	check 5.7	check 5.5	chlordane 5.3	8	3	65.0	56.7	64.0
Chlordane, 5 lbs.	15	chlordane 5.7	check 5.2	chlordane 5.4	4	7	73.0	57.6	66.0
DDT, 50 lbs.	13	check 5.8	DDT 5.1	DDT 5.6	2	5	54.0	59.0	.....
Pureed Carrots									
Dieldrin, 6 lbs.	15	check 6.3	dieldrin 6.1	dieldrin 5.7	3	1	27.0	57.6	.....
Aldrin, 8 lbs.	13	aldrin 6.5	check 5.8	check 6.6	4	0	31.0	59.0	.....
Chlordane, 10 lbs.	36	check 6.5	check 6.4	chlordane 6.3	10	4	39.0	49.0	.....
DDT, 50 lbs.	17	check 6.6	DDT 6.4	check 6.2	3	2	30.0	56.7	.....
Pureed Peas									
Dieldrin, 6 lbs.	13	check 6.1	dieldrin 6.0		4	2	46.0	.....	.....
DDT, 50 lbs.	13	check 6.2	DDT 6.5	check 6.4	2	2	31.0	59.0	.....
Chlordane, 10 lbs.	13	check 5.7	check 5.7	chlordane 5.6	2	1	23.0	59.0	.....
Aldrin, 8 lbs.	13	check 4.7	aldrin 5.4	aldrin 5.4	0	4	31.0	59.0	.....
Pureed Beans									
Chlordane, 10 lbs.	11	check 5.8	chlordane 5.6	chlordane 6.0	1	2	27.0	60.8	.....
Aldrin, 8 lbs.	12	check 5.2	aldrin 5.6	aldrin 5.5	3	4	58.0	60.0	.....
DDT, 50 lbs.	14	check 6.5	DDT 5.8		5	0	36.0	.....	.....
Dieldrin, 6 lbs.	14	check 5.6	dieldrin 5.8		3	4	50.0	.....	.....
Pureed Spinach									
Dieldrin, 6 lbs.	11	check 5.1	check 5.0	dieldrin 4.6	4	3	64.0	60.8	69.3
Dieldrin, 6 lbs.	11	check 4.9	check 4.8	dieldrin 4.8	2	1	27.0	60.8	.....
Aldrin, 8 lbs.	11	check 5.5	aldrin 4.7	check 5.1	3	0	27.0	60.8	.....
Heptachlor, 6 lbs.	13	check 5.4	check 5.4	heptachlor 5.5	1	0	8.0	59.0	.....
Chlordane, 8 lbs.	13	check 5.0	check 4.9	chlordane 5.0	1	2	23.0	59.0	.....
Pureed Beets									
Chlordane, 10 lbs.	14	check 7.6	chlordane 7.3	check 7.8	3	0	21.0	58.0	.....
Dieldrin, 6 lbs.	15	check 7.8	dieldrin 6.9		6	0	40.0		
Aldrin, 8 lbs.	15	check 7.5	aldrin 7.2		3	5	53.0		
Tomato Juice									
Aldrin, 8 lbs.	15	aldrin 8.0	check 7.7	aldrin 8.0		3	2.0	57.6	.....
Chlordane, 10 lbs.	14	chlordane 8.2	check 8.3	chlordane 8.3	1	1	14.0	58.0	.....
Dieldrin, 6 lbs.	15	check 8.2	dieldrin 7.9		6	3	60.0	.....	.....
DDT, 50 lbs.	15	check 8.3	DDT 8.4		2	3	33.0	.....	.....

and Atkin *(1)* in which the number of correct selections needed for 3 levels of significance was plotted against the total number of tests. The results were tested for significance by the χ^2 test in the manner employed by Bengtsson and each of the selections was treated as a separate test.

The pureed vegetables are served at room temperature on petri dishes. The 3 labeled samples (1, 2, and 3) are placed in the booths ready for the tasters when they come in. The samples are scored in the middle of the forenoon and the middle of the afternoon. The tasters were told that it was a triangle test comparing samples of the product grown on an untreated soil and on a soil treated with a pesticide. They were asked to match the like samples if they could and to note any off-flavor which might be attributed to the soil treatment.

These results are presented since what has been accomplished thus far may be of interest to others working on similar tests and may open up the way for an exchange of ideas which will be helpful to all concerned. It is planned to repeat these tests another season.

The fine division of the particles of the pureed vegetables appears to intensify some undesirable flavors which makes the flavor comparisons more difficult for the taster. The pureed squash samples were probably most disliked of any of the samples since the flavor was strong and there was a tendency toward a bitter aftertaste.

As is shown in Table 1, soil treatment with chlorinated hydrocarbon insecticides in some instances resulted in highly significant or significant effects and in other cases such an effect was not discernible. In the comparison of pureed squash samples, when the soil was treated with 6 lbs. dieldrin per acre, 50% of the tasters matched like samples with 53% required to give significant results at the 5% level, which would not entirely clear it of a suspected effect. However, with a 3-lb. dieldrin treatment, the results were not significant at the 5% level. With a treatment of 8 lbs. aldrin per acre, the results were similar to the results of the 6 lbs. dieldrin treatment but with 4 lbs. aldrin the tasters matched a sufficient number of samples to give significant results. In a second test comparing the same samples, the results were highly significant. In comparing the pureed squash samples from untreated and chlordane treated soils, the tasters could distinguish between the samples with highly significant results. However, in the case of the 5-lb. chlordane treatment per acre, more persons preferred the samples from the treated than the untreated soil. With 50 lbs. DDT as the soil treatment the tasters were unable to show a significant difference between the samples.

In the first test with spinach, with dieldrin as the soil treatment, there appeared to be a significant difference between the samples from the treated and untreated soils but in a second test the results were not significant. With the other soil treatments—aldrin, heptachlor, and chlordane—the tasters were unable to find a significant difference between the samples from the treated and untreated soils. The same was true for pureed beets and tomato juice. The results in Table 2 also show that the tasters in tests with pureed carrots, peas and beans were unable to note a significant difference between the samples.

Color Measurements

The color of the pureed samples of squash and carrots was measured by means of the Hunter Color Difference Meter. The technique evolved for tomato juice was applied; i.e., small area illumination, the Plexiglas sample holder, the large aperture, and the L scale were used *(4)*. The yellow tile from the set of Kitchen and Bathroom Standards developed by the U. S. Bureau of Standards was used to standardize the meter at L value of 76.2, a_L of —1.1, and b_L of 24.0.

Results of the measurements are presented in Table 3. These preliminary tests indicate that the treatments may have had an effect on the color of the pureed vegetables. As indicated by higher a_L to b_L ratios, the carrot samples from treated plots were more orange than the control samples when treated with aldrin, chlordane, and dieldrin. The squash samples from plots treated with the same materials were more yellow than their control (low a_L/b_L values). The DDT treatment in both cases had little apparent effect on the color.

TABLE 3

Results of color measurements by the Hunter Color Difference Meter of pureed squash and carrots grown on soil treated with various insecticides. Geneva, N. Y., 1952

	L	a_L	b_L	a_L/b_B
Squash				
Check	41.0	16.6	25.0	0.66
Dieldrin, 6 lbs.	42.8	13.4	26.3	0.51
Dieldrin, 3 lbs.	40.4	14.3	25.2	0.56
Aldrin, 8 lbs.	40.7	13.2	24.3	0.54
Aldrin, 4 lbs.	40.6	16.0	24.6	0.65
Chlordane, 10 lbs.	43.0	14.0	26.2	0.53
Chlordane, 5 lbs.	41.4	13.1	24.7	0.53
DDT, 50 lbs.	39.2	16.2	23.4	0.69
Carrots				
Check	40.8	18.4	23.8	0.77
Dieldrin, 6 lbs.	37.0	19.3	20.6	0.94
Dieldrin, 3 lbs.	39.2	18.0	22.8	0.79
Aldrin, 8 lbs.	37.0	19.7	21.2	0.93
Aldrin, 4 lbs.	38.4	18.6	22.0	0.85
Chlordane, 10 lbs.	36.9	18.3	21.0	0.87
Chlordane, 5 lbs.	36.6	21.0	20.1	1.04
DDT, 50 lbs.	39.8	18.2	23.1	0.79

The differences in color noted in the squash and carrot purees would appear to justify further research to determine whether the effects observed are actually attributable to the soil treatments.

SUMMARY

In one season's (1952) tests the tasters were able in some instances to show a significant difference in flavor of pureed squash grown on untreated and insecticide-treated soils. However, in the tests of the other vegetables the tasters were unable to detect significant differences in flavor.

The taste tests showed that aldrin appeared to have a detrimental effect on the flavor of pureed squash samples from squash grown on aldrin-treated soil. With chlordane, the tasters could distinguish between the samples from untreated and treated soils but did not feel that the flavor difference was detrimental to the product.

No characteristic off-flavor which could be definitely attributed to an insecticide was established by the tasters.

Color measurements of the pureed squash and carrot samples showed that soil treatments may have affected their color. Carrots from treated plots were more orange than those from control plots. Squash from treated plots were more yellow than those from control plots. The DDT treatment did not appear to affect the color of squash or carrots.

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Drying Problems in the Add-Back Process for Production of Potato Granules[a]

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The add-back process for commercial production of potato granules involves mixing freshly cooked potato with previously dried granules to obtain a friable mixture that is subsequently granulated and dried. With proper raw material, processing techniques, and equipment a product of high quality can be produced. Throughout the process mechanical damage to potato cells should be avoided in order to minimize release of free starch which causes pastiness in the reconstituted product. Factors felt to be of potential importance in relation to abrasion and impact damage in pneumatic driers used in the industry are indicated, and difficulties involved in determining the effects of these factors are outlined. Study of damage in the drying operation is complicated by the fact that damage occurring in each pass through the primary drying system is cumulative, since the granules are recycled repeatedly before being finish-dried and packed as product.

Studies are under way on two experimental driers designed specifically for drying potato granules with minimum mechanical damage. One is an air-lift drier for use in primary drying and the other is a fluidized-bed drier for use in finish-drying operations. The fluidized-bed drier is suitable for drying potato granules to moisture contents below the military specification requirement. Both driers are briefly described and results obtained in preliminary drying experiments are outlined.

Potato granules (dehydrated, precooked potatoes in granular form) are produced by the add-back process for both the armed forces and the domestic market. The product has a high package density and produces mashed potatoes when mixed with hot liquid. In the add-back process previously dried potato granules, called "seed granules" or "seed," are mixed with freshly mashed potatoes to obtain a friable mixture that is subsequently granulated and dried. Since the process has been described in considerable detail elsewhere *(1, 2)*, only a brief description is warranted here. Basically, the process involves selection of high-solids raw potatoes, washing and peeling, cooking in steam, mashing, mixing of mash and seed (in such proportions that the moisture content of the mixture is between 35 and 40% to provide a mixture that granulates readily), holding the mixture for a period, mixing in a secondary mixer to effect adequate granulation, drying, and screening. The small fraction of screenings that is coarser than about 14-mesh is separated and used as livestock feed, because it contains peel fragments and small lumps that do not granulate satisfactorily when mixed with fresh mash. The product is taken from the fraction passing a screen of about 60-mesh, since material in this fraction rehydrates with satisfactory uniformity and is adequately high in bulk density. The remaining material is recycled as seed.

Current developmental work is directed largely toward improvement of the texture of the reconstituted product. Texture after reconstitution is closely related to the processing conditions and the equipment used in manufacture. Mechanical damage to potato cells should be avoided throughout the process to minimize release of free starch, which causes the reconstituted mashed potatoes to be pasty and thus inferior in texture. However, because of a lack of definite information as to the methods and facilities required for prevention of cell damage and for control of other quality factors, no standardization of process has been achieved in the industry. Improvement of product quality is desirable for both military and domestic uses. Consequently, studies are under way to determine the effect of processing operations on the properties of the product. Olson and coworkers *(1)* have reported a number of results obtained thus far in this work. The present report deals with some of the problems encountered in drying operations and outlines preliminary results obtained with two experimental driers that were especially designed for use in the current studies.

Driers used in potato granule plants are mainly the pneumatic conveying type. In these driers the material is rapidly dried, usually in a few seconds, by dispersing it in a hot air stream. The drier comprises a device for dispersing the moist material in hot air, a duct or other enclosure through which the air conveys the granules as they dry, and means for removing the dry product from the air stream. Drier design differs from plant to plant, but in all of the various arrangements the material is conveyed through one or more duct elbows and is removed from the air stream by a cyclone separator.

It is well known that severe shattering and abrasion occur when fragile particles are pneumatically conveyed at an excessive velocity in a duct system. Sharp-turn elbows, small-diameter cyclones, and other elements that effect abrupt changes in direction of travel are especially important as sources of impact and abrasion damage. To avoid objectionable damage, the air velocity must be appropriately controlled, and the system must be designed with due consideration for the material handled. However, no definite information has been published concerning the conditions required to avoid significant damage to potato granules in a pneumatic drying system.

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Greene and coworkers *(3)* reported that potato granules produced by a freezing, pressing, and screening process were severely fractured and abraded when pneumatically dried below 20% moisture content in a horizontal-duct system at an air velocity of about 3,000 ft. per min. Since the test material was not prepared by the add-back method, however, the results may not be applicable to the add-back process. Vertical-duct pneumatic driers have been used with considerable success in Great Britain *(4)* and the United States for drying potato granules, produced by the add-back method, to moisture contents near 10%. A point in favor of the vertical-duct drier is that the air velocity required for proper conveying action is lower than for the horizontal-duct type. In a horizontal drying duct there is a tendency for particles to settle out of the air stream and form drifts on the lower interior surface of the duct unless air velocity is maintained at a rate sufficient to provide high turbulence. On the other hand, in a vertical drying duct there is no possibility of drift formation and all particles remain suspended throughout the time they are held in the duct, provided air velocity is sufficient to initiate upward movement.

When potato granules are dried to 7% moisture content, as required in current military specifications, drying is best accomplished in two operations. In a primary drying operation the moist granulated mixture (at 35-40% moisture content) is dried to about 12% moisture content. Then, in a finishing operation, the packout fraction (product to be packed) alone is dried to the military specification level. The seed fraction, which amounts to about 85% of the material discharged from the primary drier, is separated from the product fraction and recycled without being subjected to finish-drying.

Study of mechanical damage in the primary drying operation is complicated by the fact that damage occurring in each pass through the drier is cumulative, since the granules are recycled repeatedly before being finish-dried and packed as product. It is possible that slight abrasion damage effected in one pass through the drier may become greater after the granules are remoistened and mechanically mixed in the granulation step. Moreover, the relationships between drying conditions and damage are not readily determined through study of the physical properties of the product fraction. The effect of a change in drying conditions is concealed initially since, on a dry-solids basis, 85% of the material in process has been affected by the condition previously used. To determine the effect of a change it is necessary to continue processing until the original seed is adequately diluted by addition of fresh mash. Gross effects can be detected in several hours of operation. To determine small effects, the process must be continued through a large number of cycles, until steady-state conditions are reestablished. The expense involved in determining the effects of changes is so great as to discourage thorough study of differences in drier design and drying conditions.

The two experimental driers used in processing studies at this Laboratory were designed specifically for drying potato granules with minimum mechanical damage. One is an air-lift drier for use in primary drying and the other is a fluidized-bed drier for use in finish-drying operations. The air-lift drier, which is classed as a vertical-duct pneumatic drier, is of unusual design in that the drying duct contains no elbows and a low-velocity gravity separator is used in place of the conventional cyclone separator. Development of the fluidized-bed drier was undertaken to provide an improved means for reducing moisture to the level needed for good storage stability under adverse temperature conditions.

PILOT PLANT AIR-LIFT DRIER

General features of the experimental air-lift drier are shown in Figure 1. The moist granulated mixture is metered to the drier through a ribbon mixer and vibrating feeder. The granules are swept into the drying column by jet action. Hot air enters the column through the jet and the material dries as it is conveyed upward, through the main riser. At the top of the drying column, air velocity is reduced by means of an inverted truncated cone (called a "diffuser"). This cone is attached to the top of the riser. Larger particles remain in the column until dry enough to be carried over the top, whereas smaller particles are dried sooner and pass out of the column without appreciable delay. Above the diffuser the air velocity is reduced further and the product and air stream are directed downward by a deflector. The product is disengaged from the air stream in the separator body with the air escaping upward, around the deflector, through an exhaust duct at the top. The dry granules fall into an annular collector, attached to the base of the separator, and are discharged through a spout. Upon leaving the separator, the granules enter an air-slide cooler. In the cooling unit, the product is cooled to near room temperature as it flows down an inclined strip of perforated metal. Cooling is effected by forcing air at room temperature through the perforated strip, which is backed by glass cloth to obtain uniform distribution of air.

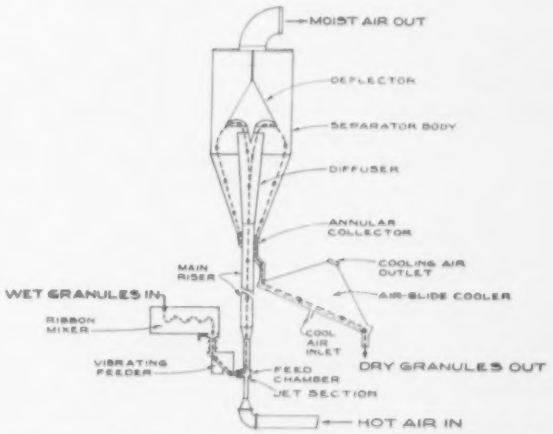

Figure 1. General features of pilot plant air-lift drier for use in primary drying operations and in drying to moderately low moisture levels.

In the experimental air-lift drier used in pilot plant studies, the main riser consists of 28 feet of round pipe, 6 inches in diameter. The total length of the drying duct, measured from the feed chamber to the top of the diffuser, is 39 feet. The separator body is 3 feet, 9 inches, in diameter and 9 feet high. Hot air is obtained by burning natural gas in an automatically-controlled, direct-combustion furnace. A blower forces the hot air and combustion products into the jet at the base of the drying column. The velocity of the air entering the drier is measured in a 6-inch duct located upstream from the jet section, and is controlled by adjusting the speed of the blower. Normally inlet

air velocity is held at either 1,500 ft. per min. or 2,000 ft. per min. At the top of the drying column air velocity is reduced to a relatively low value; for example, when drying with an inlet air temperature of about 375° F. (190° C.) and an inlet air velocity of 2,000 ft. per min., air velocity at the top of the column is approximately 280 ft. per min. For these same conditions, air velocity in the annular space between the lip of the deflector and the separator body is about 45 ft. per min. A bag-type collector, constructed of coarse muslin, is usually attached to the air discharge duct to separate any fine particles entrained in the low-velocity discharge air.

The pilot plant air-lift drier has been used mainly in primary drying operations, in which the moist granules are dried to a moisture content of approximately 12%. A small laboratory drier of the same design has been used successfully in finish-drying to a moisture content of approximately 7%. The laboratory drier, which was the first unit constructed, provided data for construction of a second model having a 10-foot drying column, 6 inches in diameter. The latter unit was used to obtain data for designing the present pilot-plant drier.

CONTINUOUS FLUIDIZED-BED DRIER

The fluidized-bed drier is sketched in Figure 2. In this unit the granules are finish-dried by hot air that enters through a horizontal, porous, refractory plate. Upon emerging from the upper face of the plate, the air separates the particles and moves

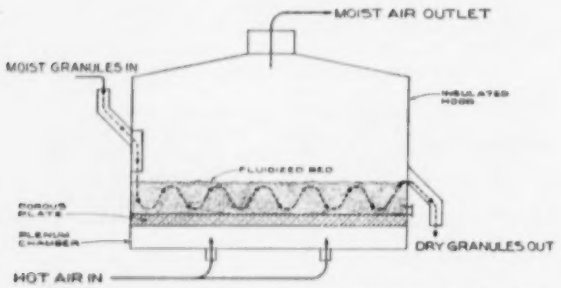

Figure 2. Continuous fluidized-bed drier for use in finish-drying operations.

them in such a manner that the bed of material behaves like a boiling liquid. The direction of movement of particles within the bed resembles the convection currents observed when a beaker of water is heated from the bottom. When in the fluidized state the material flows through the unit like a liquid. The bed in the experimental unit is 2 feet long, 6 inches wide, and 2½ inches deep. Packout from the primary drier, at about 11 to 12% moisture content, is introduced at one end of the drier and the material is dried as it flows lengthwise through the unit. The dried product is discharged over a weir. An air-slide cooler (similar to that indicated in Figure 1) immediately cools the warm product to a safe packing temperature. Because of the mixing action that occurs in the fluidized-bed drier, the particles tend to dry uniformly and overheating is easily avoided. Another advantage of the method is that drying is accomplished rapidly at unusually low air flow rates, with the result that good utilization of heat is obtained. Ledges and other obstructions that cause nonfluidized zones in the bed must be avoided in this type of drier.

In operating the unit the temperature of the entering air is usually held at a selected value and moisture content of the product is controlled by adjusting the feed rate. The air used for drying has an absolute humidity of about 0.003 lb. of water per lb. of dry air and is indirectly heated in a tubular furnace. Superficial air velocity, expressed in terms of air at 70° F. (21° C.) and 29.9 in. Hg, above the porous plate should be approximately 10 ft. per min. This flow rate can be maintained by holding the air under the loaded plate at a gauge pressure of about 4 inches of water. An aluminum-oxide porous plate, 1-inch thick, with a permeability [4] of 14 cu. ft. per sq. ft. per min. is used in the present unit. Velocities above 10 ft. per min. cause entrainment of smaller particles in the discharge air stream and are therefore avoided. For satisfactory operation of the fluidized-bed drier, the material should be dried to a moisture content of 13% or less in the primary drying operation. The design of the continuous fluidized-bed drier is based on information obtained in experiments with a batch-type fluidized-bed bin drier.

PREPARATION OF GRANULES

Russet Burbank potatoes were processed in a semi-continuous system at rates sufficient to maintain a continuous supply of material for primary drying operations. The potatoes were lightly peeled in an abrasion peeler, sliced to a thickness of about ¾ inch with trimming of discolored or decayed portions, cooked in steam at 212° F. (100° C.) for 35 minutes, and mixed with seed granules for 5 minutes in 20-quart planetary-type mixers equipped with dough hooks. The mixers were operated at low speed, with batches weighing 12 to 18 pounds. During mixing 4% sulfite solution (50% Na_2SO_3 and 50% $NaHSO_3$) was added at a rate of about 0.5 ml. per pound of mix. The mixture generally contained approximately 40% by weight fresh mash at 76% moisture content and 60% dried granules at about 12% moisture. But, as described later, it was necessary in some instances to use a higher percentage of seed to improve granulation. The mixture of mash and seed was further granulated during passage through a continuous system comprising a ribbon mixer, a slow-moving paddle-type conveyor, a variable-speed holding belt, and a secondary ribbon mixer. The granulated mixture contained approximately 38% moisture and was metered from the discharge of the secondary mixer into the drier. Feed rate to the drier was adjusted to obtain packout containing approximately 11% moisture. Particle-size classification of the dried product was determined through use of U. S. Standard sieves.

Because of equipment limitations, it was necessary to reduce retention time in the continuous portion of the granulation system when changes in drying conditions called for increased feed rate to the drier. The total mixing time (sum of retention times in planetary-type mixer, primary ribbon mixer, and secondary ribbon mixer) and the total holding time (sum of retention times for the two conveyors) were as follows:

Run No.	1	2	3	4	5	6
Total mixing time, minutes	106	67	61	127	57	45
Total holding time, minutes	101	65	49	90	45	105

A long holding time was purposely provided in Run 6 (by interposing holding cans between the two conveyors) in an attempt to compensate for reduced mixing time.

Moisture in the feed to the drier and in the seed fraction was determined by the toluene distillation method *(5)*. A ten-gram sample was used and distillation was continued for 25 minutes. Moisture in the packout fraction was determined by drying 2-gram samples in a vacuum oven for 6 hours at 70° C. at an absolute pressure of approximately 10 mm. of mercury. During drying operations, preliminary estimation of moisture in the packout was accomplished in approximately 3 minutes by means of a commercial instrument employing electrical conductivity as an indirect measurement of moisture content.*

[4] Volume of air at 70° F. (21° C.) and 29.9 in. Hg that will pass through one square foot of unloaded plate in one minute when tested under a pressure differential of 2 inches of water.

* Application of this method required a calibration curve relating instrument readings to moisture content measured by the vacuum-oven method and correction for the temperature of the sample. Subsequent determination of moisture by the vacuum-oven method showed that under the conditions of the experiments the error involved in the electrical method was less than ±0.3% absolute in 87% of the samples checked; the maximum error observed was 0.42%.

RESULTS AND DISCUSSION

Air-lift drier. Data obtained in several experimental runs with the pilot plant air-lift drier are given in Table 1. Objectives in these runs were to study drier performance at inlet air velocities of 1,500 and 2,000 ft. per min. with inlet air at various temperature levels and to determine gross effects of drying conditions on product quality. Supply air was heated to 300, 400, or 500° F. (149, 204, or 260° C.), but effective values, given in the table, were lower since some cold air was always drawn into the drying column by jet action at the feed point. The amount of cold air injected was determined in each run and the result subsequently used to calculate effective values of inlet velocity and temperature. The rate at which moist granules were fed to the drier was adjusted to obtain packout containing about 11% moisture. Each run was carried on for about 8 hours. This operating time permitted adjustment of moisture in the mix to levels favorable to adequate granulation and the determination of evaporation rates in the drier under the various run conditions, but did not allow sufficient recycling to attain steady state conditions. The seed material passed through the mixing and drying cycle approximately twice in Runs 1, 4, and 6, three times in Run 2, and 4 times in Runs 3 and 5.

TABLE 1

Evaporation obtained in experimental air-lift drier under various operating conditions [1]

Run no.	Air velocity	Inlet air temperature	Feed rate	Outlet air temperature	Moisture content (% wet basis)		Evaporation rate
	(ft./min.)	*(° F.)*	*(lb./hr.)*	*(° F.)*	*In*	*Out*	*(lb. H_2O/hr.)*
1	1500	290	68	150	38.4	11.9	20.3
2	1500	380	100	159	38.2	11.0	30.6
3	1500	475	122	166	36.8	10.3	36.0
4	2030	280	54	185	38.9	11.7	16.7
5	2030	375	119	180	37.5	11.4	35.2
6	2030	460	173	168	37.0	11.8	49.5

[1] Particle-size-distribution of granules differed in each run, as indicated in Table 2.

As indicated in Table 1, the most desirable evaporation rates were obtained in Runs 3 and 6, where the inlet air temperature was 460° F. (238° C.) and higher. However, various undesirable results were obtained in these two runs. Data given in Table 2 show the percentage of oversize material (plus 14-mesh), the moisture content of the feed, and the percentage of material finer than 60-mesh in the seed at the start and end of each run. Since the oversize material is sold as livestock feed, the amount must be kept low. The quantity of oversize material increased to objectionably high levels and the seed became coarser (minus 60-mesh fraction decreased) in Runs 3 and 6. Large particles do not make a good seed material. The original seed differed in the runs because it was necessary to start each run with seed produced in a previous run. When the seed was coarse the moisture content of the mix was reduced, by using more seed, so as to favor proper granulation. Moisture content of the mix was reduced below 38% near the start of Runs 3 and 6, but this failed to improve granulation. In the lower temperature runs good granulation was obtained with the moisture content of the mix held at approximately 38% during the major portion of each run.

TABLE 2

Effect of operating conditions on particle-size-distribution of product discharged from air-lift drier

Run number	1	2	3	4	5	6
Inlet air temperature, ° F.	290	380	475	280	375	460
Inlet air velocity, ft./min.	1500	1500	1500	2030	2030	2030
Feed moisture content, start of run, %	37.8	36.4	38.1	38.4	34.6	37.2
Feed moisture content, end of run, %	38.3	38.0	36.8	38.8	37.6	37.3
Starting seed, % −60 mesh	93	68	83	82	65	92
Seed, at end of run, % −60 mesh	89	83	68	83	83	83
Oversized material, % +14 mesh:						
At start of drying run	0.8	3.5	2.0	1.8	2.1	0.6
At end of drying run	0.7	2.0	6.2	0.9	1.8	3.8

It is believed that the variations in predrying conditions, described previously, were insufficient to account for the poor granulation obtained in the higher temperature runs. Mixing and other predrying conditions were practically identical in Runs 3 and 5 but granulation was satisfactory in the latter and poor in the former. Similarly, total mixing time was not greatly different in Runs 5 and 6, but granulation was poor in Run 6 despite the fact holding time had been increased so as to promote granulation. Consequently, it was concluded that operation of the drier under the conditions used in Runs 3 and 6 is impractical when drying in a single pass down to 11% moisture.

Entrained material deposited in the bag collector amounted to approximately 0.1% of all the material discharged from the drier in runs where inlet velocity was 1,500 ft. per min. and to about 0.5% where inlet velocity was near 2,000 ft. per min. The deposited material consisted mainly of particles smaller than 150-mesh. It was found that air mass velocity in Run 3 was slightly below the level required to convey material larger than 14-mesh out of the drying column. During this run air velocity was increased periodically to clear the column. The ejected coarse material had been scorched by prolonged exposure in the drier.

Subjective appraisal of reconstituted samples showed that the final product obtained in Run 3 had a slightly scorched flavor. Products obtained in all other runs were of satisfactory quality and there were no gross differences in color, flavor, or texture. Material deposited in the bag collector had a pasty texture and a starchy flavor when reconstituted. However, when blended with packout in proportions according to yield, the percentage of bag material was too small to effect organoleptic quality. It is not possible to state what the ultimate effect of each set of run conditions on product quality may be since it was impracticable to continue each run for a period sufficient to attain a steady state. Upon completion of the described runs an operation was carried on for several days to approach steady state conditions. In this long run operating conditions were the same as in Run 5 except that holding time was increased approximately 40%. The product obtained was of very good quality and particle-size distribution was approximately the same as obtained at the end of Run 5.

Fluidized-bed drier. Results obtained in three experimental runs with the continuous fluidized-bed drier are shown in Figure 3. In these runs packout granules at 11% moisture content (6-hour, 70° C., vacuum-oven method) were finish-dried to 5% and 3% moisture. In each run air rate was held at 10 cu. ft. per min. (equivalent to a superficial air velocity of 10 ft. per min.), inlet air temperature was held constant at either 300° F. (149° C.) or 400° F. (204° C.), and product moisture content was adjusted to the desired value by control of feed rate. The approximate average retention time, Θ, in the drier is indicated for each set of run conditions. Upon leaving the drier, the product was immediately cooled to below 100° F. (38° C.) by passage through an air-slide cooler. Temperatures measured by means of thermocouples located at the center of the porous plate (points A — A¹), ¾-inch above the porous plate (points B — B¹), and in the air-stream above the bed (points C — C¹) are indicated for each run. Points A, B, and C were located 2 inches downstream from the drier inlet and points A¹, B¹, and C¹ were located 2 inches upstream from the discharge weir. Temperatures of the product, before cooling, are also given. The temperature obtained at position B (or B¹) probably represents an average of the true temperature of the air and the particles in the fluidized bed.

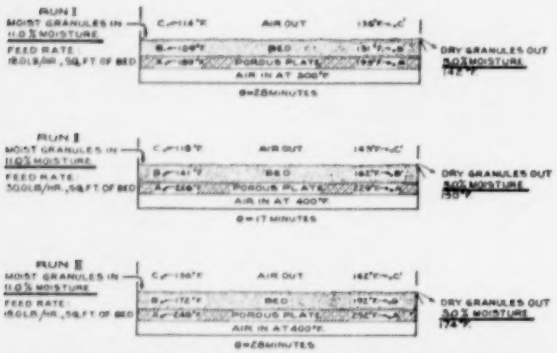

Figure 3. Results obtained when finish-drying potato granules in the continuous fluidized-bed drier. (Temperatures were measured by means of thermocouples located at points 2 inches downstream from inlet and 2 inches upstream from outlet: A-A′, plate center; B-B′, ¾″ above porous plate; C-C′, air stream above bed.)

Temperature measurements at the plate center showed that there is a large temperature drop across the plate during drying and that the drop is small when the drier is empty. This indicates that a large portion of the heat used for drying is transferred through the plate by conduction, and that the hot air is cooled considerably before it comes in contact with the fluidized material. The low temperatures of the discharge air (points C — C¹) indicate the efficient manner in which heat is used in this method of drying. The amount of water evaporated for each 1,000 B.T.U. of heat added to inlet air above an initial temperature of 70° F. (21° C.) was 0.45, 0.51, 0.40 pound in Runs I, II, and III, respectively.

Subjective appraisal showed that the freshly dried products obtained in these experiments were of good quality. There were no indications of heat damage, and the texture of the reconstituted product was good.

CONCLUSIONS

Features incorporated in the experimental air-lift drier minimize the possibility of mechanical damage in potato-granule drying operations. When potato cells are mechanically damaged in the add-back process it is difficult to determine definitely whether the fault lies in mixing operations or in the drying operation. The present drier facilitates study of the process by reducing the possibility of mechanical damage due to exposure in the drier. For the present equipment and process, inlet air temperatures near 475° F. (246° C.) resulted in impairment of product quality when the air-lift drier was used in primary drying operations with inlet air velocity at either 1,500 or 2,030 ft. per min. Results were entirely satisfactory when inlet temperature was reduced to 375° F. (191° C.) and inlet air velocity controlled at 2,030 ft. per min.

The experimental fluidized-bed drier has been found practical for drying potato granules on a pilot scale to low moisture content. Although present work with this type of drier has been confined to potato granules, the fluidized-bed method may be found useful in drying other granular heat-sensitive materials to low moisture content. In addition, the fluidization principle should be applicable to the rapid cooling of dehydrated, granular food products.

Acknowledgments

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Effects of Processing on Estimates of Raw Stock Maturity and of Textural Quality in Frozen Lima Beans[a]

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Samples of Concentrated Fordhook lima beans were subjected to experimental variations during processing, freezing, and subsequent cooking. The textures of the cotyledons were judged by a trained taste panel, and determinations were made of alcohol-insoluble solids, moisture content, starch content, embryo/seed-coat ratio, and tenderometer reading on the cooked sample. Color scores were assigned by U. S. Dept. of Agriculture inspectors. The textural quality of the beans, as determined organoleptically, was markedly influenced by the processing, freezing, and cooking variables. Only the tenderometer values on the cooked product showed a highly significant correlation with the panel scores. The experimental variations had little or no effect on color scores or alcohol-insoluble solids content.

The present U. S. Standards for Grades of Frozen Lima Beans *(13)* are largely based on ratings of color, for which a maximum of 60 score points is allowed, and on absence of defects, with a maximum of 40 points. In addition there are requirements covering flavor, odor, and tenderness, which are judged subjectively by the inspector. At the time the standards were established, varieties were commonly used that gradually lose their green color as their physiological maturity advances, becoming white when fully mature. In recent years new varieties of lima beans have been developed, many of which retain their green color at all stages of maturity. This situation has made it increasingly difficult to determine quickly and accurately the quality of frozen lima beans under the U. S. Standards.

During the ripening of lima beans, as of many other vegetables, the eating quality continually changes. At first tender and succulent, the beans gradually become tougher, the cotyledons develop a grainy texture, and the flavor of the fresh succulent bean is lost. Even when the beans have been harvested and shelled at a fairly young stage, similar loss of quality may result from improper handling or processing. In connection with processed vegetables, the terms *maturity* or *tenderness and maturity* are frequently used to refer to an organoleptic quality factor, primarily textural in nature, rather than to the stage of ripeness of the vegetable at the time of harvest. Thus *overmature* frozen lima beans are beans which are tough or starchy, whether these characteristics are due to late harvesting, to unfavorable genetic, soil, or climatic factors, or to improper handling or processing.

However, *maturity*, as used by horticulturists and physiologists, is not related to the organoleptic quality referred to above but is primarily botanical in concept. This concept of maturity forms the basis of Kertesz' *(6)* establishment of alcohol-insoluble solids as a measure of maturity in canned peas. To avoid confusion, the terms *raw stock maturity* or *physiological maturity* will be used in this paper to refer to the stage of ripeness at which the beans were harvested, and the term *textural quality* will be used for the organoleptic characteristic.

The purpose of the study, one phase of which is reported here, is to evaluate a number of objective tests with the aim of finding one which could replace or supplement the color and the tenderness ratings in the present U. S. Standards for grades. The plan included a comparison of these tests with organoleptic scores, as the most direct index of *textural quality*, and with alcohol-insoluble solids, as a probable standard of *physiological maturity*. In the present investigation, the effects of varying conditions of processing, freezing, and cooking upon the proposed objective tests, as well as upon taste scores and alcohol-insoluble solids, are reported.

The advantages of rapid objective tests for grading purposes are self-evident. For many years investigators have been concerned with the evaluation of such tests in terms of their duplicability and their degree of correlation with other tests, with harvest date, and with sensory estimates of quality. Makower *(14)* has recently reviewed the literature on objective methods of measuring raw stock maturity and textural quality *(maturity)* in peas. Various objective tests have been explored similarly in raw and processed lima beans. Alcohol-insoluble solids measurements were shown to be correlated with taste tests in processed lima beans *(8, 12)*, with time of harvest *(7)*, and with color in raw beans *(5)*. A constant increase in starch content during lima bean maturation was shown by Caldwell, *et al. (1)*, and its relation to textural quality by Lee *(12)* and Nielsen *(16)*. Suggestions of the utility of moisture content are implicit in the findings of an inverse relation between that figure and the alcohol-insoluble solids content *(5)* and time of harvest *(3, 4)*, and of a direct relation with ascorbic acid concentration *(18)*. In addition, Culpepper and Caldwell *(3)* have shown that the ratio of dry weight of the

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embryo (cotyledons) to that of the seed coat varies directly with time of harvest. This ratio was also used by Das *(5)*. Relatively high correlations of tenderometer readings *(11)* with brine separation values and of texturemeter readings *(12)* with organoleptic scores of blanched lima beans have been found. Similarly, shear-press values *(8)* of canned limas have been shown to be correlated well with both taste scores and alcohol-insoluble solids content.

EXPERIMENTAL PROCEDURE

Lima beans of the Concentrated Fordhook variety, with about 10% whites, were vined, size-graded, washed, brine floated, washed again, and cooled at a commercial processing plant. These were then placed in 32° F. storage and processed in successive experiments. The total elapsed time from vining to blanching of the last sample was 48 hours. Subsequently, the beans were made more homogeneous by separating in sugar solutions *(19)*; those floating in 25% sugar and sinking in 18% sugar were used after removal of whites and pale greens.

Processing treatments. In the standard procedure, the beans were blanched (scalded) in steam at 212° F. for 180 seconds, cooled 30 seconds in soft tap water [about 6 p.p.m. $CaCO_3$ *(2)*], sealed in No. 2 cans, and frozen and stored for seven months in circulating air at —10° F. They were cooked for 12 minutes in distilled water before tasting. In each experiment, only one of the above processing conditions was varied.

One series of beans was given different blanching temperatures (190°, 200°, 212° F.); another underwent different periods of blanching (0, 90, 180, 270, 360 seconds); a third was cooled in water of varying Ca^{++} concentration (0, 50, 100, 200, 500 p.p.m.) and also cooked subsequently in water of these respective Ca^{++} concentrations for tasting and analysis; a fourth was frozen and stored for 7 months in still air at various temperatures (—30°, —20°, —10°, 0°, +10° F.); a fifth experienced different periods of delay at room temperature before blanching and further processing (0, 1.25, 3.0, 5.5, 7.5 hours); and a final series was cooked for different periods of time before tasting and physicochemical analysis (4, 6, 9, 13, 18 minutes).

Methods of analysis. The samples were thawed by immersing the unopened cans in warm water for 3-4 hours, then dipping the beans in distilled water for 15 seconds and draining on a screen for 2 minutes. Except for the calcium ion and cooking time variations as indicated above, the samples for analysis were thawed and used directly. In all cases, 100 g. of beans were comminuted for 5 minutes in an electrically operated blender with enough cold 95% ethyl alcohol to give a final concentration of not less than 80% alcohol. The slurry thus produced was stirred thoroughly while aliquots were removed for various determinations.

Percent moisture. A 25-ml. aliquot of alcohol slurry was pipetted into a tared aluminum dish. After this was weighed, the alcohol was evaporated on a steam bath and the sample dried in a vacuum oven (70° C., 158° F., at 29.5 inches Hg.) for 48 hours. Weight loss of the calculated sample (on the basis of proportionate weight of sample in the slurry) was calculated as percentage of moisture (100 — % total solids).

Alcohol-insoluble solids (AIS).[a] A 25-ml. aliquot of alcohol slurry was weighed, then centrifuged in a tared 50-ml. tube 5-10 minutes at 2500 r.p.m. The supernatant was discarded, and centrifugation and decantation were repeated three times, after stirring with 15 ml. of cold 80% alcohol each time. Final washing, stirring, centrifuging, and decanting were repeated with 15 ml. of 95% alcohol. The alcohol of the sample was evaporated on a steam bath, and drying was carried out for 48 hours at 70° C. (158° F.) *in vacuo*. AIS were calculated on a fresh-weight basis (FWB) from the weight of the insoluble solids in the tube.

Starch. The dry AIS powder was ground in a mortar. Approximately 0.040 g. of flour was weighed into a tared 15-ml. centrifuge tube and wetted with a few drops of 95% alcohol. Water and perchloric acid, in equal amounts, were added following the methods of McCready *et al. (15)*. Glucose found was calculated as starch by multiplying by 0.90, and computed on a fresh-weight basis (FWB).

Embryo/seed coat ratio. One hundred g. of whole beans were taken from each experimental variant. The seed coats were separated from the embryos, and each group was dried in a vacuum oven (70° C. at 29.5 inches Hg.) for 24 hours and weighed. The data were used to calculate the ratio: embryo dry weight/seed coat dry weight.

Tenderometer, cooked product. Preliminary tests were made with the F.M.C. tenderometer to determine the trend of mechanical measurements with different periods of cooking (Table 1).

TABLE 1

Tenderometer values of frozen Concentrated Fordhook lima beans cooked for varying time intervals

Cooking time in minutes	Tenderometer values
0	95
4	73
8	67
12	62
16	57
20	52

From each experimental treatment, 600 g. of thawed beans were cooked 12 minutes in a liter of distilled water (except for the calcium and cooking time variations). After the beans were cooled in distilled water, the tenderometer box was filled with 180-190 g. of beans and the reading made. Thus, there were 3 readings for each treatment.

Organoleptic evaluation. Prior to the appraisal of the experimental materials, a series of preliminary investigations was carried out with samples of frozen lima beans obtained from commercial sources. These studies provided basic information from which the appraisal procedure was developed. Training and selection of the panel also occurred during this period.

It was found that increased cooking time in the range tested did not influence flavor scores, but it impaired color and increased the tenderness of the more mature samples. Color differences could be effectively masked by illumination with sodium vapor lights. Differences between samples were more clearly reflected in cotyledon texture scores than in skin texture scores. Refreezing of gravity-separated beans was shown to have no significant influence on cotyledon scores. The judges agreed upon the terms *dry* and *granular* as best describing the texture of overmature beans.

The procedure used for the final appraisal was as follows: Each frozen sample was added to ⅔ its weight of boiling distilled water (or $CaCl_2$ solution, as indicated). Twelve minutes after the liquid returned to boiling, the beans were drained. Other cooking times were used for samples where this was the variable under study. The 25 coded samples were judged under sodium lights by 11 judges on 2 successive days. The samples were coded differently each day and the judges began their tasting at different points in the series to minimize systematic errors. Scoring was on a scale of 1 to 7, 1 representing a dry, granular texture, and 7 representing a smooth, moist texture. The score reported in Table 2 for each sample is the average of 22 independent judgments.

Color scores. Duplicate samples were graded by trained inspectors of the Production and Marketing Administration of the U. S. Department of Agriculture. Color scores were assigned on the basis of a maximum of 60 points for the optimum degree of greenness according to official standards *(13)*.

RESULTS

In Table 2 are presented the results of analysis of the various experimental treatments. Coefficients of correlation *(r)* were calculated for the different analytical variables against AIS and

[a] Although varying from the official A.O.A.C. method, this method, which was precise within several tenths of a percent, was recommended by Dr. R. U. Makower of the Western Regional Research Laboratory and has also been used by Lynch, L. J., and Mitchell, R. S. (The physical measurement of quality in canning of peas. C.S.I.R.O., Australia, *Bull. 254*, 1950).

TABLE 2

Analysis of frozen Concentrated Fordhook lima beans subjected to variations in processing [1]

Experimental treatment	Percent moisture	% F. W. B.		Embryo/ seed coat	Tenderometer, cooked product	Cotyledon texture scores	U.S.D.A. color scores
		A. I. S.	Starch				
Blanch temperature (° F.)							
212°	**75.49**	**20.26**	**6.04**	**5.89**	**79**	**5.4** [2]	**59**
200°	73.45	21.70	5.11	5.11	78	4.5	60
190°	75.04	20.40	6.77	5.45	85	4.0	59
Blanch time (seconds)							
0	74.02	21.68	10.11	5.56	97	3.3	55
90 [3]	76.54	18.28	3.91	5.02	77	4.1	59
180	**75.84**	**19.05**	**2.62**	**5.33**	**80**	**5.4** [2]	**57**
270	76.61	18.98	4.46	5.66	75	5.4	56
360	76.93	18.74	6.68	5.35	74	5.4	57
Calcium ion concentration (p.p.m.)							
0	**78.75**	**18.03**	**4.23**	**6.13**	**73**	**5.4** [2]	**58**
50	78.07	18.46	3.27	5.27	75	4.8	58
100	78.32	18.54	3.61	5.63	85	5.1	57
200	78.24	18.67	7.80	5.92	98	4.4	58
500	77.57	19.27	3.55	6.47	109	4.3	58
Freezing temperature [4] (° F.)							
−30°	80.61	15.40	3.86	5.24	72	5.3	57
−20°	76.89	18.45	5.12	5.04	70	5.2	56
−10°	75.32	19.24	4.65	5.87	71	— [5]	56
0°	75.35	20.42	4.86	5.53	76	4.6	57
+10°	76.33	19.16	3.83	5.54	75	4.0	56
Delay (hours)							
0	**76.27**	**18.82**	**5.64**	**5.71**	**74**	**5.4**	**59**
1.25	75.83	19.55	3.81	5.60	76	5.4	59
3.0	77.71	17.74	4.10	4.77	75	5.0	58
5.5	75.57	20.14	4.39	5.51	81	4.3	58
7.5	77.01	18.60	4.58	4.91	81	4.0	58
Cooking time (minutes)							
4	80.61	15.73	5.43	5.23	82	3.5	58
6	78.47	18.11	4.03	5.62	80	4.0	56
9	77.34	18.64	3.54	5.92	75	4.9	57
13	78.25	17.81	3.66	5.85	75	5.6	58
18	78.86	17.44	3.01	5.47	65	5.9	59

[1] Control in bold face type.
[2] In control group of processing treatment. Values of tasted control assigned to these.
[3] Average of two sets of samples.
[4] No control possible because of lack of blower apparatus in cold storage room.
[5] Not tasted.

cotyledon texture scores, respectively. These coefficients are given in Table 3. The correlations were further analyzed for significance by the "F" test *(17)*. The "F_r" values are also shown in Table 3. On the basis of a variance ratio of 4.21 at the 5% level and 7.68 at the 1% level, it may be seen that the correlations of moisture with AIS and tenderometer readings with taste panel scores are highly significant and the correlations of starch with AIS and starch with panel scores significant, statistically. It may further be seen that the U. S. Department of Agriculture color scores are virtually constant throughout.

TABLE 3

Coefficients of correlation between analytical variables and A. I. S. and taste panel scores

Variable	A. I. S.		Cotyledon texture score	
	r	F_r	r	F_r
Percent moisture	−0.831 [1]	60.58	+0.133	0.49
Starch	+0.418 [2]	5.73	−0.403 [2]	5.24
Embryo/seed coat	+0.149	0.61	+0.209	1.23
Tenderometer	+0.298	2.64	−0.552 [1]	11.86
A. I. S.	—	—	−0.195	1.07

[1] Correlation significant at the 1% level of probability.
[2] Correlation significant at the 5% level of probability.

Most of the indices analyzed showed no constant relation to the varying processing conditions. The most striking relation was exhibited by the taste panel scores. The effects of processing treatments on organoleptic evaluation of textural quality are indicated graphically in Figure 1. To determine the significance of this apparent relation between treatments and panel scores, an analysis of variance was made *(17)*. The "F" values of the taste scores for each treatment are given in Table 4. A comparison with corresponding "F" values at the 5% and 1% levels shows that the scores in all treatments, except that with calcium ion, were highly significant. In the calcium treatment, the scores were significant (*i.e.*, below the 5% level). Attention may be called to the very sensitive relation of the tenderometer readings to the effects of varying calcium ion concentration, as shown in Table 2.

DISCUSSION

From the data presented it is apparent that variations in the processing and cooking of frozen lima beans may markedly influence the textural quality of the product as served. From the trends shown in Figure 1 and the "F" values in Table 4, it also appears that the effects of the experimental variations are readily detectable to the taste panel. Lower cotyledon texture scores are associated with increased delay between vining and blanching, decreased blanching temperature, decreased blanch time (below 180 seconds), increased freezing temperatures, decreased cooking time, and increased calcium concentration in the processing and cooking water.

TABLE 4

"F" values for cotyledon texture scores in each processing treatment

Treatment	F		
	Calculated	$F_{0.05}$	$F_{0.01}$
Blanch temperature	8.79	3.14	4.94
Blanch time	12.77	2.46	3.51
Calcium concentration	3.20	2.46	3.51
Freezing temperature	6.56	2.72	4.03
Delay	6.96	2.46	3.51
Cooking time	17.97	2.46	3.51

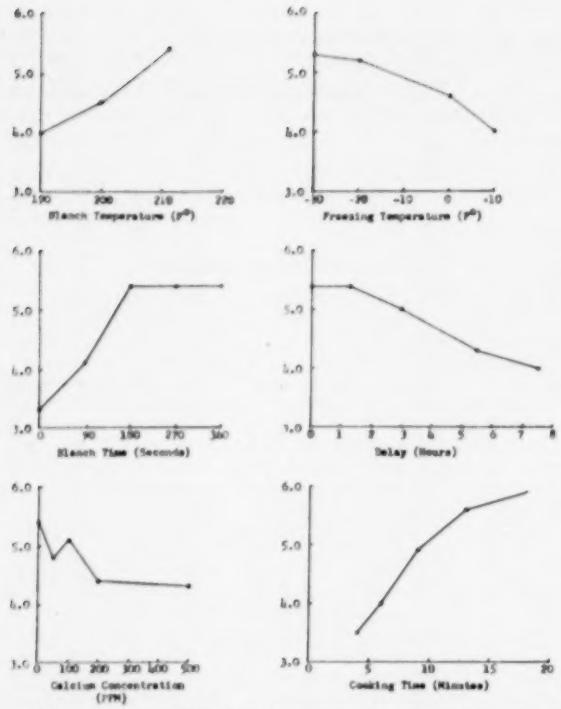

Figure 1. Organoleptic texture scores for frozen lima beans undergoing variations in processing.

Although similar effects of delay and blanch time on lima bean "quality" were noted by Kramer and Mahoney *(9)* and Kramer and Smith *(10)*, their taste scores were based on composite features—which included flavor, odor, and color as well as texture.

Of the objective tests only the tenderometer value of the cooked beans reflects these changes in quality at the 1% level of probability. The tenderometer value appears to be particularly sensitive to toughening due to calcium in the cooking water. The starch content is correlated significantly with the organoleptic scores; however, the data show a consistent trend only with cooking time as the variable.

While the alcohol-insoluble solids and percent moisture values are very closely correlated, neither appears to be correlated with cotyledon texture scores. This indicates that these two tests did not clearly reflect differences in textural quality of the product introduced by the variations in the handling, processing, and cooking conditions investigated in this study. The correlation between starch content and AIS value is significant at the 5% level of probability. While AIS and moisture determinations have been well established as indices of the *physiological* maturity of lima beans, they do not measure the textural quality of the cooked frozen product under the conditions of the present study. The U. S. Department of Agriculture color scores remain at an unvaried level which is not significantly related to any of the factors employed.

Thus, it is clear that if textural quality is used to determine maturity, the complete history of the frozen beans must be kept uniform. Otherwise, grades and standards will lack equivalence. If physiological maturity (as indicated by alcohol-insoluble solids or moisture content) is used as a standard, variations in processing treatments will have a relatively minor influence in grade determination.

SUMMARY

Organoleptic evaluations of the maturity of lima beans in terms of cotyledon texture clearly reflect the influence of certain variations in the processing and cook procedure, lower scores (dried, more granular cotyledons) resulting from the following variations: increased delay time after vining, decreased blanch temperature, decreased blanch time (below 180 seconds), increased freezing temperature, decreased cooking time, and increased calcium content of the processing and cooking water.

Color scores and alcohol-insoluble solids contents, as measures of physiological maturity, are relatively uninfluenced by processing and cooking variations.

The tenderometer value of the cooked beans also reflects these changes and is particularly sensitive to the effects of cooking in water containing calcium ions.

While the correlation between starch content and cotyledon texture scores is significant at the 5% level of probability, the starch determination appears to be much less useful than the tenderometer reading on the cooked product as an index of textural quality.

Correlation between starch content and alcohol-insoluble solids is significant at the 5% level of probability, and that between moisture and alcohol-insoluble solids is significant at the 1% level of probability.

The embryo/seed coat ratio is poorly correlated with either alcohol-insoluble solids or textural quality.

Although the alcohol-insoluble solids and moisture values show a highly significant correlation with each other, neither of these indices is related to the cotyledon texture of the cooked beans when the processing and cooking procedures are varied.

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Butyric Acid Fermentation in Canned Pears and Tomatoes[a]

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Outbreaks of butyric fermentation in commercially canned Flemish Beauty pears and whole tomatoes have been shown to be caused by Clostridium pasteurianum. Since spoilage is associated with high pH values in the product, the addition of citric acid to canned Flemish Beauty pears is suggested as a means of control. With tomatoes, since acidification is not a practical treatment, strict adherence to recommended processing schedules, together with good factory sanitation, is recommended.

Outbreaks of butyric fermentation in canned Flemish Beauty pears occur periodically in processing plants in British Columbia. There is some indication that this spoilage is primarily associated with pears canned from fruit held in storage over an extended period. The spoilage is characterized by the evolution of large amounts of gas containing carbon dioxide and hydrogen. The contents of the can have a strong butyric odor and show greatly increased acidity with pH values as low as 4.1.

Bartlett pears, probably due to their lower pH, have not been subject to this type of spoilage. Atkinson, Strachan, and Moyls *(1)* have found the pH value of British Columbia canned Bartlett pears to range from a minimum of 3.5 to a maximum of 4.2 with a mean value of 3.76. On the other hand, canned Flemish Beauty pears had a minimum pH of 4.28, a maximum of 4.67, and a mean of 4.38.

Recently a case of butyric spoilage has been observed in commercially canned whole tomatoes. Records over the past 12 years at the Summerland Fruit and Vegetable Processing Laboratory show the minimum pH of tomato juice, puree, pulp, and whole tomatoes produced in British Columbia to range from 4.0 to 4.2, the maximum 4.48 to 4.61, with a mean value of 4.32.

Fermentation of acid canned foods has been studied by Townsend *(5)* and Spiegelberg *(3, 4)*. Townsend *(5)* isolated spore forming butyric anaerobes from samples of canned tomatoes, pears and figs. The organisms, identified as strains of *Clostridium pasteurianum*, grew readily at pH 4.0 but less vigorously at pH 3.6 to 4.0. To destroy the spores required 25 to 40 minutes heating at 100° C. (212° F.) in phosphate buffer at pH 7.0. His data indicated that to destroy the spores in tomato juice at 100° C. took twice as long (i.e., 20 minutes) at pH 4.5 as at pH 4.1, and nearly five times as long as at pH 3.8. Results with pear and apricot juices were similar. Townsend *(5)* suggested acidification as a means of controlling spoilage by this organism in order to avoid very severe processes which would have deleterious effects on the quality of the product.

Spiegelberg *(3)* found that rough and smooth strains of *Clostridium pasteurianum* were responsible for butyric fermentation of canned pineapple. These strains were similar to those described by Townsend *(5)*, but were less resistant to heat and acid. In canning experiments with pineapple, Spiegelberg *(4)* showed that butyric spoilage occurred in samples at pH 4.5 or higher, even when the processing temperatures were greatly increased over the cannery standard of 87.8° C. (190° F.)

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in the fruit from the cooker. On the other hand when the pH was below 4.4, even underprocessed samples showed no fermentation. Spiegelberg *(4)* concluded that butyric spoilage could be controlled by maintaining the pH of the product at or below 4.4 and processing to give a temperature of 87.7° C. (190° F.) or higher in the fruit from the cooker.

EXPERIMENTAL PROCEDURE

Isolation of organism. Samples of commercially canned Flemish Beauty pears showing evidence of butyric spoilage were inoculated into nutrient broth of pH 7.4 containing 3% dextrose and 0.8% of yeast extract, a modification of the medium used by Spiegelberg *(3)*. These and all subsequent cultures were incubated at 30° C. (86° F.) in Brewer jars to insure anaerobic conditions. After 72 hours the medium showed heavy turbidity with production of large volumes of gas and a strong butyric odor. The pH of the medium was reduced from 7.4 to 4.1. The gas produced was composed of carbon dioxide and hydrogen in varying proportions.

Microscopic examination indicated the predominant flora to be curved Gram-positive rods, 5 to 8 μ in length by 0.5 to 0.75 μ thick. Polar staining was evident in a few cases. No spores, and very few clostridial forms, were to be seen even after prolonged incubation. The culture weakened and failed to grow after 3 to 5 transfers. This necessitated a study of more effective cultural techniques and methods of inducing sporulation. Details of this work will be reported in another paper.

As a result of preliminary tests it was found that the addition of an excess of sterile calcium carbonate to the actively fermenting cultures and reincubation for 12 to 14 hours resulted in enlargement of the vegetative cells, the development of numerous clostridia, and profuse sporulation. The vegetative cells at this stage were from 10 to 14 μ in length by 0.75 to 1.5 μ thick. After a further 48 to 72 hours incubation, the spores were seen to be free from the sporangia, with very few vegetative cells remaining.

Pure cultures were obtained by heating the spore suspension for 5 minutes at 80° C. (176° F.), plating on dextrose agar and picking colonies into dextrose broth containing yeast extract. Small, white, lenticular, sub-surface acid colonies were characteristic. The procedure was repeated several times.

On the basis of sugar fermentation and other standard biochemical tests the organism has been identified as a strain of *Clostridium pasteurianum*. In most respects it is identical with the *Cl. pasteurianum* described by Townsend *(5)*.

Samples of fermented canned tomatoes were examined and the organism responsible for spoilage isolated. It was found to be identical with the strain of *Cl. pasteurianum* isolated from fermented canned pears.

In a survey of a plant encountering this spoilage in canned Flemish Beauty pears, the organism was isolated from the bottom of wooden trays used for carrying and stacking filled cans of fruit prior to syruping.

Processing experiments. With the object of determining practical methods of controlling spoilage by *Clostridium pasteurianum*, samples of pears were canned, inoculated, and processed under various conditions of pH and temperature.

The cans were inoculated by introducing 1 ml. of spore suspension, containing approximately 200,000 spores, in droplet form throughout each can of packed fruit prior to the addition of syrup. Uninoculated control cans were prepared at the same time. Twenty fluid ounce size cans (307 x 409) were used in all tests.

In the first series of tests, Bartlett pears were canned in syrup of 35% concentration adjusted with sodium citrate buffer solution to give pH values in the finished product ranging from 3.3 to 5.0. In the second series, Flemish Beauty pears were canned in 35% syrup to which citric acid had been added in concentrations of 0.1, 0.2 and 0.3%. To accentuate adverse conditions of pH, Flemish Beauty pears were used which had reached their maximum storage life.

The recommended processing treatment for Bartlett pears in 307 x 409 size cans was employed *(2)*. The prepared cans were exhausted in steam at 98.9° C. (210° F.) for approximately 4 minutes, or until the syrup temperature at the centre of the can reached 71.1° C. (160° F.). The cans were then immediately sealed, heated for 17 minutes in boiling water, and then water cooled to 21.1° C. (70° F.). This treatment gave can centre temperatures at the end of the 17-minute cook period varying from 88.3° to 95.6° C. (191° to 204° F.), with a mean temperature of 92.2° C. (198° F.). Continuous records of can centre temperatures taken during the cook period showed marked variation in the length of time individual cans were subjected to temperatures of 87.8° C. (190° F.) or higher. This time varied from 5 minutes to 16 minutes. However, 85% of the samples were exposed to temperatures of 87.8° C. (190° F.) or higher for periods from 12 to 14 minutes.

In addition, 2 series of underprocessed Bartlett pears, inoculated with *Clostridium pasteurianum* as previously described, were prepared by exhausting to a temperature of 60° C. (140° F.), sealing and processing for 5 and 10 minutes in boiling water, followed by cooling as in the standard procedure. The 10-minute heating period gave final syrup temperatures of 86.7° to 94.4° C. (188° to 202° F.) with a mean temperature of 91.9° C. (197.5° F.). The majority of cans in this series were exposed to temperatures of 87.8° C. (190° F.) or higher, for periods of 5 to 6 minutes. The 5-minute cook gave final syrup temperatures of 83.3° to 92.2° C. (182° to 198° F.) with a mean temperature of 89° C. (192.5° F.). The majority of samples were subjected to temperatures of 87.8° C. (190° F.) or higher for 2 to 3 minutes.

Syrup temperatures were recorded during exhausting and processing by means of the Brown Electronik Potentiometer. In all instances the thermocouples were located in the syrup at the geometric centre of the can.

All cans were stored at a temperature of 21.1° to 26.7° C. (70 to 80° F.). Examination for swelled cans was made daily over a period of 14 weeks.

EXPERIMENTAL RESULTS

Table 1 shows the effect of variation in pH on the growth of *Clostridium pasteurianum* in processed Bartlett pears. No spoilage was observed in pears buffered to pH 3.3 to 4.15, either in adequately processed or underprocessed samples. In the pH range 4.15 to 4.25 no fermentation occurred in samples which had received the standard commercial process. Fruit underprocessed in this pH range showed spoilage in 1 out of 5 samples, or 20%. At pH 4.3 to 4.4, standard and underprocessed samples showed 50% and 77% spoilage, respectively. At pH 4.5 to 5.0 all samples fermented. No difference was found between the 2 series of underprocessed samples.

TABLE 1
Effect of pH on growth of Clostridium pasteurianum in canned buffered Bartlett pears

pH	Process	No. of samples	No. fermented	% fermented
3.3 - 4.15	Standard	9	0	0
	Underprocessed	10	0	0
4.15 - 4.25	Standard	6	0	0
	Underprocessed	5	1	20
4.3 - 4.4	Standard	6	3	50
	Underprocessed	9	7	77
4.5 - 5.0	Standard	9	9	100
	Underprocessed	10	10	100

In Table 2 data are presented to demonstrate the control of *Clostridium pasteurianum* in acidified Flemish Beauty pears receiving the standard heat sterilization process. Eighty percent of unacidified samples fermented, as did those containing 0.1% citric acid. Where 0.2% citric acid was present 25% of samples fermented, while in the samples containing 0.3% acid, no spoilage was encountered. It should be noted that the Flemish Beauty

Technical Program and Abstracts

FOURTEENTH ANNUAL MEETING

OF THE

INSTITUTE OF FOOD TECHNOLOGISTS

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JUNE 27 through JULY 1, 1954
LOS ANGELES, CALIFORNIA

YOUR ANNUAL MEETING

The program of the 14th annual meeting of the Institute of Food Technologists, presented in the following pages, emphasizes the high purpose and responsible character of the enterprise of the Institute in promoting the best interests of its members, the profession of food technology and the public welfare.

The technical papers are replete with new scientific and technical information, well calculated to keep our membership informed concerning current developments on the frontiers of food technology. They deal with a host of food and container problems and touch on the vital interests of all segments of the food industry.

The new products, materials, instruments and process equipment on display in the exhibit halls, will supply a most important educational supplement to the technical program. Made available by leading food and allied industries, these exhibits bring into focus the most recent technical and engineering advances.

The social events, interwoven in the fabric of the program pattern, emphasize the traditions of the Institute and feature the gracious quality of Southern California hospitality. They are designed to generate good fellowship and stimulate personal exchange of thoughts and ideas. If you make the most of the opportunities which they encourage, you are sure to enjoy very pleasant and profitable returns.

With boundless energy and unwavering devotion to the ideals of the Institute, superb arrangements have been made by the Southern California Section to meet all of the requirements for a highly successful meeting. The Section joins with me in urging every member to attend.

BERTON S. CLARK
President

TECHNICAL PROGRAM AND ABSTRACTS

GENERAL AND SOCIAL EVENTS

(All events will be held in the Biltmore Hotel, unless otherwise noted)

Saturday, June 26

Executive Committee Meeting, 10:00 a.m.—Conference Room 7

Editorial Board Meeting, 7:30 p.m.—Conference Room 6

Sunday, June 27

National Council Meeting, 10:00 a.m.—Conference Room 1

Registration, 1:30 p.m. to 9:00 p.m.—Galeria

Ladies Get-together Tea, 4:00 p.m. to 6:00 p.m. —Music Room

Social Hour, courtesy Southern California Section, 8:00 p.m.—Renaissance Room

Monday, June 28

University of California Alumni Breakfast, 7:30 a.m.—Conference Room 4

Registration, 8:00 a.m. to 7:00 p.m.—Galeria

Opening General Session, 10:00 a.m. — Renaissance Room

U.S.D.A. Research Service Luncheon, 12:15 p.m. —Crystal Room, Clark Hotel, 426 South Hill

University of Massachusetts Alumni Luncheon, 12:15 p.m.—Conference Room 5

Appert Award Banquet, Honoring Dr. Charles N. Frey, Recipient, 7:00 p.m. — Biltmore Bowl (followed by entertainment and dance)

Committee on Citrus Products, 5:00 p.m.—Conference Room 1

Committee on Taste Testing and Consumer Preference, 5:00 p.m.—Conference Room 2

Tuesday, June 29

Section Officers' Breakfast, 7:30 a.m.—Conference Room 4

Mass. Institute of Technology Breakfast, 7:30 a.m.—Conference Room 5

Plant Trips—schedule follows in program

Babcock-Hart Award Luncheon, Honoring Dr. E. J. Cameron, Recipient, 12:00 p.m. — Renaissance Room

Committee on Frozen Foods, 5:15 p.m. — Conference Room 2

Committee on Education for Food Technologists, 5:15 p.m.—Conference Room 8

Pectin Round Table, 8:00 p.m. — Conference Room 4

Wednesday, June 30

Canadian Breakfast, 7:30 a.m. — Conference Rooms 3 and 4

Registration, 8:00 a.m. to 5:00 p.m.—Galeria

General Session, 10:00 a.m.—Biltmore Bowl

Outing for all at Knott's Berry Farm, 2:00 p.m. to 9:30 p.m.—Buses leave from Grand Avenue entrance of Biltmore

Fried chicken dinner, compliments Southern California Section

Thursday, July 1

Plant Trips—schedule follows in program

Installation Luncheon, 12:00 p.m.—Renaissance Room

LADIES' PROGRAM

Ladies' Lounge

There will be a lounge reserved for women guests of the I.F.T. in the Biltmore Hotel. Information on all events may be obtained there, and all trips will assemble there. If you prefer independent sight-seeing or shopping, our committee will help you arrange the trips. Our general Hospitality Committee will have maps and literature about interesting local attractions as well as free tickets to radio and television performances.

Tickets Required for All Functions

All scheduled events will be controlled by the use of tickets which may be obtained at the Registration Desk. For those events away from the hotel it will be necessary to make a charge for the cost of transportation. The bus fare is shown for each event. Tickets must be obtained not later than the day prior to the event so that adequate transportation may be arranged. All buses leave from the Grand Avenue Entrance of the Biltmore Hotel.

Sunday, June 27

4-6 p.m. All ladies are invited to a Get-Acquainted Tea in the Music Room of the Biltmore Hotel. Wives of our President and President-Elect will be honored guests.

8-10 p.m. Social Hour for all registered persons —the Renaissance Room, Biltmore Hotel.

Monday, June 28

8:45 a.m. Trip to Hollywood movie studios and homes of stars. Lunch, on your own, at fabulous Farmers Market. Time allowed to visit interesting shops and food stalls. Transportation $2.00.

4:00 p.m. Return to Biltmore for visit to the Exhibits at the Convention. The exhibitors will be honored to have you show this interest in their displays.

7:00 p.m. Appert Award Banquet in world renowned Biltmore Bowl. This will be followed by entertainment and a dance with the famous Bowl Orchestra.

Tuesday, June 29

8:45 a.m. Trip to Laguna Beach Art Colony, the "Riviera of America." A sidewalk art exhibit; scores of fascinating shops. See Laguna's famous pottery being made. Clam chowder prepared and served right on the beach; demonstrations of spear fishing and skin diving. Lunch at picturesque Laguna Hotel. If there is time a stop will be made at Mission San Juan Capistrano. Transportation $3.00.

Wednesday, June 30

Morning for resting or local shopping on your own. Our committee will direct you to the various stores.

2:00 p.m. Join your husband for an outing at Knott's Berry Farm and Ghost Town. You will get an insight into Old Western Frontier Days. You'll never forget this trip. Be sure to wear comfortable clothes and walking shoes, and take along a warm jacket. An old-fashioned fried chicken dinner, compliments of the Southern California Section. Return to Biltmore about 9:30 p.m. Transportation $1.00.

Thursday, July 1

Shopping on your own in our many delightful stores. Or how about taking one of the plant trips? They will be interesting and educational.

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PLANT TRIPS

Visits to several plants have been scheduled during the week. Since transportation must be arranged it is necessary that tickets be secured the day before the trip. A charge is made for each trip to cover the cost of transportation only. All trips start from the Grand Avenue Entrance of the Biltmore Hotel.

Tuesday, June 29

8:30 a.m. *Fish Processing.* Visit the Starkist (Tuna) and the Van Camp Sea Food Company plants at Terminal Island. Return to Biltmore about 12:30 p.m. Transportation $1.50.

9:00 a.m. *Citrus Processing.* Visit the Exchange Orange Products plant at Ontario and the Exchange Lemon Products plant at Corona. Return to the Biltmore about 5:30 p.m. Transportation $2.50.

11:30 a.m. *Brewery.* Visit the Pabst Brewing Company plant in Los Angeles; luncheon served. Trip limited to 125. Return to Biltmore Hotel about 4:30 p.m. Transportation $1.50.

1:30 p.m. *Laboratory.* Visit the U. S. Department of Agriculture Fruit and Vegetable Chemistry Laboratory, Pasadena. Return to the Biltmore Hotel about 5:00 p.m. Transportation $1.50.

Thursday, July 1

8:30 a.m. *Vegetable Shortening.* Visit the new Lever Brothers soap and vegetable shortening plant. Return to Biltmore Hotel about 12:00. Transportation $1.00.

8:30 a.m. Combination trip to F. Ritter and Company, extract and flavorings manufacturer; then to the Knudsen Creamery Co. plant in Los Angeles. Return to the Biltmore about 12:00. Transportation $1.50.

1:30 p.m. Trip to the new Carnation Co. Research Laboratory at Van Nuys. Return to the Biltmore about 5:00 p.m. Transportation $1.50.

1:30 p.m. Trip to American Can Co. plants. Both tin cans and paper milk containers are fabricated in these plants. Return to the Biltmore about 5:00 p.m. Transportation $1.00.

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SUMMARY OF TECHNICAL PROGRAM

Monday, June 28

10:00 a.m. General Session — Renaissance Room, Biltmore Hotel

Greetings from the Southern California Section

Presidential Address — Dr. Berton S. Clark

The Inquiring Mind—Dr. L. A. DuBridge, President, California Institute of Technology

Our Daily Bread—Walter H. Staves, Minister, Congregational Church of the Chimes, Van Nuys, California

Official Opening of the Exhibits

2:00 p.m. Section A—Problems in Fruit and Vegetable Research and Technology. Sunkist Board Room, Sunkist Building, 707 W. Fifth St.

2:00 p.m. Section B — Wine Stability. Edison Auditorium, Edison Building, 601 W. Fifth St.

2:00 p.m. Section C — Special Purpose Foods. Renaissance Room, Biltmore Hotel

2:00 p.m. Section D—Research Papers—Poultry, Eggs and Milk. Biltmore Conference Room 1

2:00 p.m. Section E—Research Papers. Biltmore Conference Room 2

Tuesday, June 29

9:00 a.m. Section F—Consumer Testing. Sunkist Board Room, Sunkist Building, 707 W. Fifth St.

9:00 a.m. Section G—Development and Administration of Federal and State Food and Drug Laws. Edison Auditorium, Edison Building, 601 W. Fifth St.

9:00 a.m. Section H — The Life and Accomplishments of Edwin Bret Hart. Renaissance Room, Biltmore Hotel

9:00 a.m. Section I—What's New in Food Packaging. Biltmore Conference Room 2

9:00 a.m. Section J—Pectin and Pectic Materials in Relation to Food Processing and Preservation. Biltmore Conference Room 1

Pectin Round Table, 8:00 p.m., Tuesday, Biltmore Conference Room 1

9:00 a.m. Section K — Advances in Fruit and Vegetable Dehydration. Biltmore Conference Room 8

2:00 p.m. Section L—Marketing. Sunkist Board Room, Sunkist Building, 707 W. Fifth St.

2:00 p.m. Section G *(continued)*—Development and Administration of Federal and State Food and Drug Laws. Edison Auditorium, Edison Building, 601 W. Fifth St.

2:00 p.m. Section M—Frozen Foods. Biltmore Conference Room 2

2:00 p.m. Section N—Research Papers: Irradiation Studies and Others. Biltmore Conference Room 1

2:00 p.m. Section K *(continued)*—Advances in Fruit and Vegetable Dehydration. Biltmore Conference Room 8

Wednesday, June 30

10:00 a.m. General Session. Biltmore Bowl, Biltmore Hotel
Nicholas Appert Award Address
DR. CHARLES N. FREY
Babcock-Hart Award Address
DR. E. J. CAMERON
Food, Nutrition, and Mankind in the Future
Food Technology and the International Technical Assistance Programs

Thursday, July 1

9:00 a.m. Section O—Citrus Concentrates. Sunkist Board Room, Sunkist Building, 707 W. Fifth St.

10.00 a.m. Section P—Recent Basic Investigations in Food Science. Edison Auditorium, Edison Building, 601 W. Fifth St.

9:00 a.m. Section Q—Food Engineering Symposium. Renaissance Room, Biltmore Hotel

9:00 a.m. Section R—Flavor Changes in Foods as Influenced by Applied Chemicals. Biltmore Conference Room 1

9:00 a.m. Section S — Research Papers: Vegetables. Biltmore Conference Rooms 3 and 4

2:00 p.m. Section P *(continued)* — Citrus Concentrates. Sunkist Board Room, Sunkist Building, 707 W. Fifth St.

2:00 p.m. Section Q *(continued)*—Recent Basic Investigations in Food Science. Edison Auditorium, Edison Building, 601 W. Fifth St.

2:00 p.m. Section R *(continued)* — Food Engineering Symposium. Renaissance Room, Biltmore Hotel

2:00 p.m. Section T—Research Papers: Fish and Meat. Biltmore Conference Room 1

2:00 p.m. Section U — Research Papers: Fruits. Biltmore Conference Rooms 3 and 4

DETAILED PROGRAM

MONDAY MORNING — JUNE 28

Renaissance Room—Biltmore Hotel

GENERAL SESSION

Chairman: PRESIDENT BERTON S. CLARK

10:00—CALL TO ORDER

10:05—GREETINGS FROM THE SOUTHERN CALIFORNIA SECTION, IFT
General Chairman MILTON E. POWELL, Knudsen Creamery Co., Los Angeles, Calif.

10:15—PRESIDENTIAL ADDRESS: Progress Report on IFT Activities
BERTON S. CLARK.

10:30—THE INQUIRING MIND
L. A. DUBRIDGE, President, California Institute of Technology, Pasadena, Calif.

11:00—OUR DAILY BREAD
WALTER H. STAVES, Minister, Congregational Church of the Chimes, Van Nuys, Calif.

11:30—OFFICIAL OPENING OF THE EXHIBITS
JOHN S. BECKETT, Aseptic Thermo Indicator Co., North Hollywood, Calif.

MONDAY AFTERNOON — JUNE 28

Section A—Sunkist Board Room
Sunkist Building, 707 W. Fifth Street

Problems in Fruit and Vegetable Research and Technology

Chairman: JOHN H. MACGILLIVRAY
University of California, Davis, California

2:00— Introductory Remarks
John H. MacGillivray

2:15— 1. The Role of Research in Solving Raw Product Problems of the Processor—Scheduling Plantings and Predicting Harvest Maturities for Processing Vegetables
H. L. SEATON, Continental Can Company, Inc., Chicago, Ill.

2:50— 2. Temperatures in Relation to Deciduous Fruit Production
DILLON S. BROWN, University of California, Davis, Calif.

3:25— 3. The Development of New Vegetable Varieties by Plant Breeding
ALLEN TROTTER, Associated Seed Growers, Inc., Milpitas, Calif.

4:00— 4. Problems in Handling Raw Commodities in Food Processing Plants
D. G. SORBER, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

4:35— VISIT YOUR EXHIBITS

MONDAY AFTERNOON — JUNE 28

Section B—Edison Auditorium
Edison Building, 601 W. Fifth Street

Wine Stability

Chairman: HAROLD W. BERG
University of California, Davis, California

2:00— 5. Relation of Nitrogen Content of the Must to Colloidal Stability of the Wine
ANDRE TCHELISTCHEFF, DIMITRI TCHELISTCHEFF, and JOSEPH E. HEITZ, Beaulieu Vineyards, Rutherford, Calif.

2:15— 6. Combined Method for Heat and Cold Stabilization of Wines
CHARLES B. HOLDEN, JR., Peralta Wine Company, Fresno, Calif.

2:30— 7. Colloid Chemistry of Copper Casse
A. LUKTON and M. A. JOSLYN, University of California, Berkeley, Calif.

2:50— 8. The Influence of pH and Total Acidity on the Stability of Sherry Wine
RAUL DE SOTO, Roma Wine Co. and HANS WARKENTIN, The Twining Laboratories, Fresno, Calif.

3:05— 9. Stabilizing Apple Wine With Enzyme
H. Y. YANG, Oregon State College, Corvallis, Oregon.

3:25— 10. Sulphur Dioxide—Its Importance in Helping Maintain Stability in Wines
E. C. SKOFIS, Italian Swiss Colony, Clovis, Calif.

3:40— 11. The Lactic Acid Bacteria and Stability of California Wines
REESE H. VAUGHN, University of California, Davis, Calif.

4:00— 12. Bottle Stability *vs.* Composition of Wines
J. H. FESSLER, Berkeley Yeast Laboratory, Berkeley, Calif.

4:15— VISIT YOUR EXHIBITS

MONDAY AFTERNOON — JUNE 28

Section C—Renaissance Room—Biltmore Hotel

Special Purpose Foods

Chairman: E. GEIGER
Van Camp Sea Food Company, Terminal Island, California and Medical School, University of Southern California Los Angeles, California

2:00— Introductory Remarks
E. GEIGER

2:10— 13. Technological Problems in Preparation of Special Purpose Foods
H. W. SCHULTZ, Oregon State College, Corvallis, Ore.

2:35— 14. Present Needs for Special Purpose Foods in Medical Diets
TELFER B. REYNOLDS, University of Southern California, School of Medicine, Los Angeles, Calif.

3:00— 15. Pediatric Food Problems
ROBERT A. ULSTROM, School of Medicine, University of California, Los Angeles, Calif.

3:25— 16. Problems in Feeding of Older Persons
ROBERT R. COMMONS, School of Medicine, University of California and Endocrine Clinic, Los Angeles County General Hospital, Los Angeles, Calif.

3:50— 17. Problems in Practical Feeding of Dietetic Foods
RUTH LITTLE, White Memorial Hospital, Los Angeles, Calif.

4:15— 18. Special Purpose Foods (Fruits and Vegetables)
C. A. WEAST, Flotill Products, Incorporated, Stockton, Calif.

4:40— 19. The Metabolism of Sorbitol and Mannitol
ARNE N. WICK, Scripps Metabolic Clinic, La Jolla, Calif.

5:05— 20. Effects of Iodized Salt in Processed Fruit and Vegetables
N. KOJIMA and H. D. BROWN, The Ohio State University, Columbus, Ohio.

5:30— VISIT YOUR EXHIBITS

MONDAY AFTERNOON — JUNE 28

Section D—Biltmore Conference Room 1

Research Papers—Poultry, Eggs and Milk

Chairman: GEORGE F. STEWART
University of California, Davis, California

2:00— 21. Chlortetracycline and the Control of Poultry Spoilage
A. RICHARD KOHLER, HARRY P. BROQUIST, and W. H. MILLER, Lederle Laboratories Division, American Cyanamid Company, Pearl River, N. Y.

2:20— 22. Flavor of Untreated, Oiled and Thermostabilized Shell Eggs After Storage at 34° F.
SALLY FOSS, FRANCES CARLIN and OWEN COTTERILL, Iowa State College, Ames, Iowa.

2:40— 23. Destruction of Enzyme Activity in Eggs by Heat Treatment
OWEN J. COTTERILL, Iowa State College, Ames, Iowa and A. R. WINTER, H. C. COOK and H. H. WEISER, The Ohio State University, Columbus, Ohio.

3:00— 24. The Control of Bacteria in Shell Eggs
A. R. WINTER and PATRICIA SHIELDS, Ohio Agricultural Experiment Station, Columbus, Ohio.

3:20— 25. The Effect of High Temperature Storage on the Content of Salmonella and the Functional Properties of Dried Egg White

GEORGE J. BANWART and JOHN C. AYRES, Iowa Agricultural Experiment Station, Ames, Iowa.

3:40— 26. Determination of Solubility Index of Spray Dried Eggs

S. J. BISHOV and J. H. MITCHELL, JR., Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill.

4:00— 27. Acetoglycerides—New Fat Products of Potential Value for the Food Industry

R. O. FEUGE, Southern Utilization Research Branch, U.S.D.A., New Orleans, La.

4:20— 28. Difference in Heat Stability of the Phosphates Can Serve as a Test for Adulteration of Raw Milk with Heated Milk

SOCRATES A. KALOYEREAS, Louisiana State University, Baton Rouge, La.

4:40— VISIT YOUR EXHIBITS

MONDAY AFTERNOON — JUNE 28

Section E—Biltmore Conference Room 2

Research Papers

Chairman: E. B. OBERG
The Carnation Company, Van Nuys, California

2:00— 29. Theory and Application of Continuous Pressure Filtration to the Extraction of Irish Moss

D. A. DAHLSTROM, the Eimco Corp., WALTER HOCK, STANLEY M. OSRI, and ANDREW SINGLETON, The Kraft Foods Company, Research Laboratories, Glenview, Ill.

2:20— 30. The Antioxidant Properties of Natural Spices in Simple Oil-in-Water Emulsions

J. R. CHIPAULT, G. MIZUNO and W. O. LUNDBERG, The Hormel Institute, University of Minnesota, Austin, Minnesota.

2:40— 31. The Antioxidant Properties of Natural Spices in Foods

J. R. CHIPAULT, G. MIZUNO and W. O. LUNDBERG, The Hormel Institute, University of Minnesota, Austin, Minn.

3:00— 32. Maple Sirup. VII. Contribution to the Carbohydrate Chemistry of Maple Sap and Sirup

WILLIAM L. PORTER and NANCY HOBAN, Eastern Utilization Research Branch, U.S.D.A., Philadelphia, Penn.

3:20— 33. Maple Sirup. VIII. A Simple and Rapid Test for the Analysis of Maple Sirup for Invert Sugar

J. NAGHSKI, C. O. WILLITS, and WILLIAM L. PORTER, Eastern Utilization Research Branch, U.S.D.A., Philadelphia, Penn.

3:40— 34. A Study of Certain Factors Affecting the Growth of Flor Yeast

KENNETH FREIBERG and W. V. CRUESS, University of California, Berkeley, Calif.

4:00— 35. Variation in Flavor Judgments in a Group Situation

DEAN FOSTER, CORNELIA PRATT, NOEL SCHWARTZ and WILLIAM H. JONES, United States Testing Company, Hoboken, N. J., and Los Angeles, Calif.

4:20— 36. Determining the Size Compliance of Foods

CHARLES H. COLEMAN and JOHN E. DESPAUL, Chicago Quartermaster Depot, Chicago, Ill.

4:40— 37. The Food Technologist, The Medical Officer and Food Acceptance Techniques in the Development of Food Items for Hospital and Clinic Patients

W. FRANKLIN DOVE, University of Illinois College of Medicine, Chicago, Ill., and Illinois State Department of Public Health.

5:00— VISIT YOUR EXHIBITS

TUESDAY MORNING — JUNE 29

Section F—Sunkist Board Room
Sunkist Building, 707 W. Fifth Street

Consumer Testing

Chairman: HELEN L. HANSON
Western Utilization Research Branch, U.S.D.A.
Albany, California

9:00— 38. Consumer Wine-Preference Methodology Studies at California Fairs

H. W. BERG, F. FILIPELLO, E. H. HINREINER, and A. D. WEBB, University of California, Davis, California.

9:20— 39. Development of a Scale for Measuring Soldiers' Food Preferences

LYLE V. JONES, University of Chicago, Chicago, Ill. and DAVID PERYAM, Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill.

9:40— 40. Comparative Sensitivity of Rating Scale and Paired Comparison Methods for Measuring Consumer Preference

FRANCIS J. PILGRIM, Quartermaster Food and Container Institute For The Armed Forces, Chicago, Ill.

10:00— 41. Effect of Prior Tests on Consumer Response to Foods

H. L. HANSON, J. G. DAVIS, A. A. CAMPBELL, J. H. ANDERSON, and H. LINEWEAVER, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

10:20— 42. Single Product or Paired Comparison Consumer Tests—Which Should You Use?

GWENETH J. HEDLUND, BERNICE ALBRECHT, R. L. WYATT, General Mills Research Laboratories, Minneapolis, Minn.

10:40— **43.** A Household and a Laboratory Type of Panel for Testing Consumer Preference

PAUL G. MILLER, JOHN H. NAIR and ARTHUR J. HARRIMAN, Thomas J. Lipton, Inc., Hoboken, N. J.

11:00— **44.** Investigation of Food Products at the Consumer Level

H. R. BALDWIN, Kraft Foods Company, Research Laboratories, Glenview, Illinois.

11:20— **45.** The Development of Special Rations—An Application of Sensory Analytical Techniques

ERNEST E. LOCKHART, ROLAND BISTANY, and MABLE C. MERRITT, Massachusetts Institute of Technology, Cambridge, Mass.

11:40— VISIT YOUR EXHIBITS

TUESDAY MORNING — JUNE 29

Section G—Edison Auditorium
Edison Building, 601 W. Fifth Street

Development and Administration of Federal and State Food and Drug Laws

Chairman: CHARLES W. KAUFMAN
Kraft Foods Company, Chicago, Illinois

9:00— Introductory Remarks
Charles W. Kaufman

9:10— **46.** Canning Industry Interest in Recent Food and Drug Legislation

E. J. CAMERON and J. R. ESTY, National Canners Association, Washington, D. C., and Berkeley, Calif.

9:40— **47.** The Milling Industry—Its Interest in Food and Drug Activities and Legislation

F. N. PETERS, Quaker Oats Company, Chicago, Ill.

10:10— **48.** The Program of the Food Protection Committee of the National Research Council

EMIL MRAK, University of California, Davis, Calif.

10:40— **49.** Toxicological Determination of Suitability of Food Additives

H. J. DEUEL, JR., University of Southern California, Los Angeles, Calif.

11:10— **50.** Do Present Grade Standards for Processed Foods Meet the Needs of the Consumer

ELIZABETH M. ELBERT and CARL R. FELLERS, University of Massachusetts, Amherst, Mass.

10:45— VISIT YOUR EXHIBITS

TUESDAY MORNING — JUNE 29

Section H—Renaissance Room—Biltmore Hotel

The Life and Accomplishments of Edwin Bret Hart

Chairman: L. E. CLIFCORN
Continental Can Company, Inc.
Chicago, Illinois

9:00— **51.** Edwin Bret Hart—His Life and Memories of Him

H. T. SCOTT, Wisconsin Alumni Research Foundation, Madison, Wis.

9:25— **52.** Thirty-Two Years' Association with E. B. Hart

C. A. ELVEHJEM, University of Wisconsin, Madison, Wis.

9:50— **53.** Contributions of E. B. Hart to Animal Nutrition

S. LEPKOVSKY, University of California, Berkeley, Calif.

10:15— **54.** The Impact of E. B. Hart's Contributions on Human Nutrition

E. M. NELSON, Food and Drug Administration, Washington, D. C.

10:40— **55.** E. B. Hart's Contributions to Food Technology

K. G. WECKEL, University of Wisconsin, Madison, Wis.

TUESDAY MORNING — JUNE 29

Section I—Biltmore Conference Room 2

What's New in Food Packaging

Chairman: K. W. BRIGHTON
American Can Company, Maywood, Illinois

9:00— **56.** The Importance of the Relationship Between Food and Packaging Technology

L. J. HAYHURST, Kraft Foods Company, Research Laboratories, Glenview, Ill.

9:20— **57.** Current Status of Plastic Films in Food Packaging

C. C. SUTTON and C. M. WOODCOCK, Central Laboratories, General Foods Corporation, Hoboken, New Jersey.

9:55— **58.** New Developments in Paperboard Containers

HOWARD S. GARDNER, DAVID G. EDWARDS and MONROE F. SMITH, Fibreboard Products Inc., Antioch, California.

10:20— **59.** New Developments in Metal Cans

R. H. LUECK, R. W. PILCHER, and K. W. BRIGHTON, American Can Company, Maywood, Ill.

10:45— **60.** New Developments in Glass Containers

R. L. CHENEY, Glass Container Manufacturers Institute, New York.

11:10— **61.** New Developments in Shipping Containers for Food

HARRY R. KATTELMAN, Container Laboratories, Inc., San Francisco, Calif.

11:35— VISIT YOUR EXHIBITS

TUESDAY MORNING — JUNE 29

Section J—Biltmore Conference Room 1

Pectin and Pectic Materials in Relation to Food Processing and Preservation

Chairman: REESE H. VAUGHN
University of California, Davis, California

9:00— **62.** The Discoloration of Pectin Gels

G. E. LIVINGSTON, N. PANDIT, M. A. STEINBERG and C. R. FELLERS, University of Massachusetts, Amherst, Mass.

9:15— **63.** Polyphosphates Improve Calcium-Pectinate Gels

CLAUDE H. HILLS, Eastern Utilization Research Branch, U.S.D.A., Philadelphia, Penn.

9:30— **64.** The Chromatographic Estimation of Acetyl Groups in Pectins

Z. I. KERTESZ and MARGARET LAVIN, Cornell University, Geneva, N. Y.

9:45— **65.** The Precipitation of Pectinic Acids by Aluminum Salts

GUIDO DeLUCA and M. A. JOSLYN, University of California, Berkeley, Calif.

10:05— **66.** The Pectolytic Activity of Extracts of Types of Onions

H. P. MELOCHE, JR., and F. W. FABIAN, Michigan State College, East Lansing, Mich.

10:20— **67.** Glycosodic Hydrolysis of Pectic Materials by Tomato Polygalacturonase

BOR SHIUN LUH, SHERMAN J. LEONARD, and HERMAN J. PHAFF, University of California, Davis, Calif.

10:40— **68.** Characterization of Pectinesterase in Orange Concentrates and Related Model Systems

R. J. McCOLLOCH and R. G. RICE, Western Utilization Research Branch, U.S.D.A., Pasadena, Calif.

11:00— **69.** Mode of Action of Fruit Pectolytic Enzymes and of the Formation of Pectin in Fruit

EUGENE F. JANSEN, R. M. McCREADY, ELIZABETH A. McCOMB, CHARLES G. SEEGMILLER and BERNARD AXELROD, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

11:20— **70.** The Hydrolysis of Pectic Acid and Some Oligouronides by Yeast Polygalacturonase (YPG)

A. L. DEMAIN and H. J. PHAFF, University of California, Davis, Calif.

11:40— **71.** Incidence and Enzymatic Activity of Molds Found In Indiana Tomatoes

L. S. WHITE, F. W. FABIAN and E. S. BENEKE, Michigan State College, East Lansing, Mich.

12:00— VISIT YOUR EXHIBITS

SPECIAL NOTE: PECTIN ROUND TABLE

Tuesday—8:00 P.M.

Biltmore Conference Room 1

Convenor: I. J. HUTCHINGS
H. J. Heinz Co., Pittsburgh, Penn.

TUESDAY MORNING — JUNE 29

Section K—Biltmore Conference Room 8

Advances in Fruit and Vegetable Dehydration

Chairman: J. R. WAGNER
Quartermaster Food and Container Institute for the Armed Forces
Chicago, Illinois

9:00— **72.** Investigation of Methods for Incorporation of Natural Fruit Flavors into Fruit Powders

T. H. SCHULTZ, K. P. DIMICK, and B. MAKOWER, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

9:20— **73.** Rates of Nonenzymatic Browning of White Potato

CARL E. HENDEL, VERNON G. SILVEIRA, and W. O. HARRINGTON, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

9:40— **74.** Calcium Chloride as a Non-Enzymic Browning Retardant for Dehydrated White Potatoes

M. SIMON and J. R. WAGNER, Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill., and V. G. SILVEIRA and C. E. HENDEL, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

10:00— **75.** Factors Affecting the Texture of Rehydrated Potato Granules

D. E. SEVERSON and A. M. COOLEY, University of North Dakota, Grand Forks, N. D., and MORRIS SIMON, Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill.

10:25— **76.** A Method for the Comparison of Consistency in Potato Granule Samples Appraised at Different Times

ELIZABETH R. WOOD, R. L. OLSON and MARVEL-DARE NUTTING, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

10:45— **77.** A Comparison of Through Air Flow and Cross Air Flow Methods for the Initial Dehydration of Sweet Corn

A. I. NELSON, M. P. STEINBERG, R. R. LEGAULT, and H. W. HORTON, University of Illinois, Urbana, Ill., and H. W. FRITZSCHE, Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill.

11:00— **78.** Production Feasibility of Dehydrated Sweet Corn

H. W. FRITZSCHE, Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill., and R. W. KUENEMAN, J. R. Simplot Company, Caldwell, Idaho.

11:15— **79.** Production Feasibility of Dehydrated Green Beans

H. W. FRITZSCHE and J. R. WAGNER, Quartermaster Food and Container Institute for the Armed Forces, and EARL M. LITTWILLER, Oregon State College, Corvallis, Oregon.

11:35— VISIT YOUR EXHIBITS

TUESDAY AFTERNOON — JUNE 29

Section L—Sunkist Board Room
Sunkist Building, 707 W. Fifth Street

Marketing

Chairman: ROY H. WALTERS
General Foods Corporation, New York, N. Y.

2:00— **80.** New Business Opportunities in the Grocery Field

HERB FRANK, General Foods Corporation, New York, N. Y.

2:30— **81.** Marketing and Distribution of Foods

RUSSELL Z. ELLER, Sunkist Growers, Los Angeles, Calif.

3:00— **82.** Food Advertising

SHERWOOD DODGE, Foote, Cone and Belding, New York, N. Y.

3:30— **83.** Evaluation of Marketing Programs

WALTER WASHBURN, Young and Rubicam, New York, N. Y.

4:00— VISIT YOUR EXHIBITS

TUESDAY AFTERNOON — JUNE 29

Section G (Continued)—Edison Auditorium
Edison Building, 601 W. Fifth Street

Development and Administration of Federal and State Food and Drug Laws

Chairman: CHARLES W. KAUFMAN
Kraft Foods Company, Chicago, Illinois

2:00— Remarks: Charles W. Kaufman

2:05— **84.** The United States Food and Drug Law: Its Profound Economic and Social and Legal Importance

CHARLES WESLEY DUNN, Food Law Institute, New York, N. Y.

2:45— **85.** Problems Encountered in the Development and Administration of a State Food and Drug Regulatory Program

MILTON P. DUFFY, Bureau of Food and Drug Inspection, State of California, Los Angeles, Calif.

3:15— **86.** Recent Amendments to the Federal Food, Drug and Cosmetic Act

GORDON R. WOOD, Food and Drug Administration, Los Angeles, Calif.

3:45— **87.** The Federal Law and Proposed Amendments as They Affect Food Standards

A. M. GILBERT, ESQ., Davis and Gilbert, Attorneys-at-Law, New York, N. Y.

4:15— VISIT YOUR EXHIBITS

TUESDAY AFTERNOON — JUNE 29

Section M—Biltmore Conference Room 2

Frozen Foods

Chairman: K. G. DYKSTRA
Birds Eye Division, General Foods Corporation
Albion, New York

2:00— **88.** Protective Packaging of Frozen Foods

J. G. WOODROOF and ETHYL SHELOR, Georgia Experiment Station, Experiment, Georgia.

2:20— **89.** Effect of Sucrose and Ascorbic Acid on Quality Retention in Fresh and Frozen Strawberry Puree

D. G. GUADAGNI, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

2:40— **90.** Color of Citrus Products. I. Color Differences of Citrus Juices and Concentrates Using the Hunter Color Difference Meter

R. L. HUGGART and F. W. WENZEL, Florida Citrus Experiment Station, Lake Alfred, Fla.

3:00— **91.** Mandatory Standards Program on Quality Factors for Frozen Asparagus and Peas—An Industry Approach

I. Purpose and Organization of Program

H. P. SCHMITT, National Association of Frozen Food Packers, Washington, D. C.

II. Selection of Official Analytical Procedures

CURTIS J. WILDER, Oregon State College, Corvallis, Oregon.

III. Evaluation of Results

A. KRAMER, University of Maryland, College Park, Maryland.

4:00— **92.** Effect of Freezing Conditions on Appearance of Frozen Poultry

A. A. KLOSE and M. F. POOL, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

4:20— **93.** Control of Mold in Strawberries by Treatment in the Field, in Transit, and in the Processing Plant

A. H. NAGEL, W. B. NEUBURG, and K. E. DUGGAN, Birds Eye Division, General Foods Corporation, Hillsboro, Ore.

4:40— **94.** Recent Progress in the Dehydrofreezing of Fruits and Vegetables

WILLIAM F. TALBURT and F. E. LINDQUIST, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

5:15— Meeting of Committee on Frozen Foods
K. G. DYKSTRA, Presiding.

TUESDAY AFTERNOON — JUNE 29

Section N—Biltmore Conference Room 1

Research Papers—Irradiation Studies and Others

Chairman: FRANK L. GUNDERSON
Washington, D. C.

2:00— **95.** The Use of Ionizing Radiations in the Eradication of Insects in Packaged Military Rations

BERNARD E. PROCTOR, ERNEST E. LOCKHART, SAMUEL A. GOLDBLITH, ALBERT V. GRUNDY, GEORGE E. TRIPP, SOL DAVISON, and MARCUS KAREL, Department of Food Technology, Massachusetts Institute of Technology, Cambridge, Mass., and Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill.

2:20— **96.** Theoretical Considerations in Food Processing by Gamma Radiation

STANLEY E. CHARM, SAMUEL A. GOLDBLITH, and BERNARD E. PROCTOR, Department of Food Technology, Massachusetts Institute of Technology, Cambridge, Mass.

2:40— **97.** Studies in the Cold Sterilization of Liquid Foods Using High Energy Resonance Radiation

HARRY E. GUNNING and MILTON E. PARKER, Illinois Institute of Technology, Chicago, Ill.

3:00— **98.** Food Physics

JOHN P. O'MEARA, Southwest Research Institute, San Antonio, Tex.

3:20— **99.** Method of Determination of Gas in Vacuum Packed Food Products

N. S. YANICK, Kraft Foods Company, Research Laboratories, Glenview, Ill.

3:40—**100.** The Quantitative Determination of Coloring Materials in Butter and Margarine

HENRY M. ESPOY and HAROLD M. BARNETT, Barnett Laboratories, Long Beach, California.

4:00—**101.** Resistance of *Clostridium parabotulinum* to Sorbic Acid

GEORGE K. YORK, II and REESE H. VAUGHN, University of California, Davis, Calif.

4:20—**102.** An Investigation of the Use of Plastic Film Packages for Heat Processed Foods

K. H. HU, A. I. NELSON, R. E. LEGAULT, and M. P. STEINBERG, University of Illinois, Urbana, Ill.

4:40—**103.** Starchy Thickening Agents for Canned Food Products

JOHN GORTON DAVIS, JOYCE H. ANDERSON and HELEN L. HANSON, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

5:00— VISIT YOUR EXHIBITS

TUESDAY AFTERNOON — JUNE 29

Section K (Continued)—Biltmore Conference Room 8

Advances in Fruit and Vegetable Dehydration

Chairman: M. SIMON
Quartermaster Food and Container Institute for the Armed Forces
Chicago, Illinois

2:00—**104.** Progress of Research in the United Kingdom on Fruit and Vegetable Dehydration

H. R. BARNELL, Scientific Adviser's Division, Ministry of Food, Aberdeen, Scotland; E. G. B. GOODING, Ministry of Food Research Establishment, Aberdeen, Scotland; and H. G. WAGER, Low Temperature Research Station, Department of Scientific and Industrial Research, Cambridge, England.

2:30—**105.** Problems in Production of Tomato Juice Powder

VERN F. KAUFMAN, FRANCIS WONG, D. H. TAYLOR, and WILLIAM F. TALBURT, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

2:50—**106.** Storage Stability of Tomato Juice Powder

F. E. LINDQUIST, W. D. DIETRICH, J. G. HARRIS, and H. S. OLCOTT, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

3:10—**107.** Studies on Reconstitution of Certain Dehydrated Fruits and Vegetables

JEAN I. SIMPSON, IRENE C. L. CHANG and EVELYN C. APPEL, Syracuse University, Syracuse, N. Y., and Marion C. Bollman, Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill.

3:30—**108.** Continuous Vacuum Dehydration of Orange Juice

WM. R. DORSEY, SUMNER I. STRASHUN, ROBERT E. KILBAUGH, Vacu Dry Company, Oakland, California and ROBERT M. HOPKINS, Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill.

3:50—**109.** Design and Construction of a Continuous Columnar Dryer

EDWARD SELTZER and FREDERICK A. SAPORITO, Research Laboratory, Thomas J. Lipton, Inc., Hoboken, N. J.

4:10—**110.** New Through-Flow Rotary Dryer for the Partial Drying of Apple Slices

WILLIAM C. ROCKWELL, EDISON LOWE, GEORGE S. SMITH, and MYRON J. POWERS, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

4:30—**111.** Sweet Corn Dehydration—the Falling Rate Phase

R. G. GARNER, A. I. NELSON, R. R. LEGAULT, and L. B. HOWARD, The University of Illinois, Urbana, Illinois.

4:50— VISIT YOUR EXHIBITS

WEDNESDAY MORNING — JUNE 30

Biltmore Bowl—Biltmore Hotel

GENERAL SESSION

Chairman: PRESIDENT BERTON S. CLARK

10:00—NICHOLAS APPERT AWARD ADDRESS
CHARLES N. FREY, Consultant, Scarsdale-on-Hudson, New York.

10:30—BABCOCK-HART AWARD ADDRESS
E. J. CAMERON, National Canners' Association, Washington, D. C.

11:00—FOOD, NUTRITION, AND MANKIND IN THE FUTURE
GEORG BORGSTROM, Swedish Institute for Food Preservation Research, Göteborg, Sweden.

11:30—FOOD TECHNOLOGY AND THE INTERNATIONAL TECHNICAL ASSISTANCE PROGRAMS
Z. I. KERTESZ, New York State Agricultural Experiment Station, Cornell University, Geneva, N. Y.

THURSDAY MORNING — JULY 1

Section O—Sunkist Board Room
Sunkist Building, 707 W. Fifth Street

Citrus Concentrates

Chairman: W. R. ROY
Minute Maid Corporation, Plymouth, Florida

9:00— Introductory Remarks
W. R. ROY, Minute Maid Corporation, Plymouth, Fla.

9:05—112. Producing Florida Citrus for Frozen Concentrate
JOHN W. SITES and A. F. CAMP, Citrus Experiment Station, Lake Alfred, Florida.

9:35—113. Characteristics of Concentrate Made from Different Varieties of Citrus Fruits
F. W. WENZEL and E. L. MOORE, Citrus Experiment Station, Lake Alfred, Florida.

9:55—114. Plant Sanitation and Microbiological Control Methods
R. W. KILBURN and PALMER TUTHILL, Florida Citrus Canners Co-op, Lake Wales, Fla.

10:15—115. The Slide-Plate Method of Estimating the Number of Viable Organisms Present in Orange Juice
KENNETH M. ROWELL, The Exchange Orange Products Company, Ontario, California.

10:40—116. Sources and Detection of Voges-Proskauer Reactants in California Valencia Orange Juice
C. GORDON BEISEL, R. WILLARD DEAN, ROBERT L. KITCHEL and KENNETH M. ROWELL, Exchange Orange Products Company, Ontario, Calif., and C. W. NAGEL and REESE H. VAUGHN, University of California, Davis, Calif.

11:00—117. The Role of the Evaporator in the Production of Frozen Concentrates
E. J. KELLY, E. J. Kelly & Associates, Inc., and H. W. SCHWARZ, Minute Maid Corporation, Plymouth, Fla.

11:20—118. The Effect of Concentration on Quality of Frozen Orange Juice with Particular Reference to 58.5° and 42° Brix Products
C. W. DUBOIS and D. E. MURDOCK, Minute Maid Corporation, Plymouth, Fla.

11:40—119. Differential Method of Cloud Determination in Frozen Orange Concentrates
R. J. MCCOLLOCH and R. G. RICE, United States Department of Agriculture, Pasadena, Calif.

12:00— VISIT YOUR EXHIBITS — LAST CHANCE

THURSDAY MORNING — JULY 1

Section P—Edison Auditorium
Edison Building, 601 W. Fifth Street

Recent Basic Investigations in Food Science

Chairman: AKSEL G. OLSEN
General Foods Corporation, Hoboken, N. J.

10:00—120. Newer Concepts of Optimum Nutrition
CHARLES GLEN KING, Nutrition Foundation, New York, N. Y.

Discussion Leader:
WENDEL GRIFFITH, University of California at Los Angeles, Los Angeles, Calif.

11:00—121. Mineral Nutrition—The Role of Trace Elements
CONRAD ELVEHJEM, University of Wisconsin, Madison, Wis.

Discussion Leader:
BERNARD L. OSER, Food Research Laboratories, Long Island City, N. Y.

VISIT YOUR EXHIBITS

THURSDAY MORNING — JULY 1

Section Q—Renaissance Room—Biltmore Hotel

Food Engineering Symposium

Chairman: CURTIS E. MAIER
Continental Can Company, Inc.
Chicago, Illinois

9:00— Welcome
CURTIS E. MAIER, Continental Can Company, Inc., Chicago, Ill.

9:05—122. The Team—The Food Engineer and the Food Technologist
FRANK K. LAWLER, *Food Engineering*, McGraw-Hill Publishing Co., New York, N. Y.

9:40—123. Engineering Aspects of Food Production Unit Processes
PAUL C. WILBUR, Food Machinery and Chemical Corporation, San Jose, Calif.

10:30—124. The Interrelationship of Science, Technology, and Food Engineering to the Technical Success of Food Production

WILLIAM R. JOHNSTON and LAWRENCE ATKIN, the Fleischmann Laboratories, Standard Brands, Inc., Stamford, Conn.

11:05—125. The Food Engineer and Food Industry Profits

RAYMOND STEVENS, Arthur D. Little, Inc., Cambridge, Mass.

11:40— VISIT YOUR EXHIBITS — LAST CHANCE

THURSDAY MORNING — JULY 1

Section R—Biltmore Conference Room 1

Flavor Changes in Foods as Influenced by Applied Chemicals

Chairman: C. H. MAHONEY
National Canners Association
Washington, D. C.

9:00— Introductory Remarks

C. H. MAHONEY, National Canners Association, Washington, D. C.

9:05—126. Analytical Problems Encountered in Attempts to Characterize and Localize Metabolized Insecticide Residues in Food Products

FRANCIS A. GUNTHER, University of California Citrus Experiment Station, Riverside, Calif.

9:35—127. Evaluation of Pesticides for Entomological Effectiveness and Influence on Crop Flavor

E. GORDON LINSLEY, University of California, Berkeley, Calif. and ELLY HINREINER, University of California, Davis, Calif.

10:05—128. The Food Flavor Problem in Pesticide Research

W. H. EWART, University of California Citrus Experiment Station, Riverside, Calif.

10:25—129. Do Pesticides Cause Off-Flavors in Citrus Products?

E. A. BEAVENS, G. J. KELLER, and R. G. RICE, Western Utilization Research Branch, U.S.D.A., Pasadena, Calif.

10:40—130. The Use of the Triangular and Multiple Comparison Taste Panel Methods for Detecting Possible Off-Flavors in Vegetables Treated with Insecticides

A. KRAMER, University of Maryland, College Park, Md.

11:00—131. Studies Leading to the Development of a "Standardized Procedure" for Making Flavor Evaluations of Canned Foods Treated with Chemical Pesticides

ALICE N. BRIANT, New York State College of Home Economics, Cornell University, Ithaca, N. Y.; WILBUR A. GOULD, The Ohio State University, Columbus, Ohio; J. C. HENING, New York State Agricultural Experiment Station, Geneva, N. Y.; ELLY HINREINER, University of California, Davis, Calif.; A. KRAMER, University of Maryland, College Park, Md.; W. A. MACLINN, New Jersey Agricultural Experiment Station, New Brunswick, N. J.; EDWARD ROSS, State College of Washington, Pullman, Wash.; LOIS SATHER, Oregon State College, Corvallis, Ore.; MARDELL D. TOMPKINS, American Can Company, Maywood, Ill.; K. G. WECKEL, University of Wisconsin, Madison, Wis.

11:30— VISIT YOUR EXHIBITS — LAST CHANCE

THURSDAY MORNING — JULY 1

Section S—Biltmore Conference Rooms 3 and 4

Research Papers—Vegetables

Chairman: H. W. SCHULTZ
Oregon State College, Corvallis, Oregon

9:00—132. The Surface Darkening of Sliced Beets

WALTER L. CLARK, Cornell University, Ithaca, N. Y. and J. C. MOYER, New York State Agricultural Experiment Station, Cornell Univeristy, Geneva, N. Y.

9:20—133. Factors Associated with Potato Texture

F. A. BETTELHEIM and C. STERLING, University of California, Davis, Calif.

9:40—134. Factors Affecting the Quality of Pre-Peeled Potatoes

E. E. ANDERSON, W. B. ESSELEN, and C. R. FELLERS, University of Massachusetts, Amherst, Mass.

10:00—135. Effect of Temperature and Oxygen Supply on the Production of Acetaldehyde and Alcohol by Frozen Green Peas

R. E. MOORE and J. J. DAVID, Macdonald College of McGill University, Quebec, Canada.

10:20—136. Film Deposition of Tomato Juice on Heat Exchanger Coils

H. W. ADAMS, L. B. HOWARD, R. R. LEGAULT and A. I. NELSON, University of Illinois, Urbana, Ill.

10:40—137. Protecting Tomato Juice Against Flat Sour Spoilage

N. W. DESROSIER and G. D. LA BAW, Purdue University, Lafayette, Indiana.

11:00—138. Consistency of Paste and Puree from Pearson and San Marzano Tomatoes

BOR SHIUN LUH, WESLEY H. DEMPSEY, and SHERMAN J. LEONARD, University of California, Davis, Calif.

11:15—139. Determination of Color in Shelled Walnuts

LOUIS B. ROCKLAND and PATRICIA C. SLODOWSKI, Western Utilization Research Branch, U.S.D.A., Pasadena, Calif.

11:30—140. Measurement of Color of Ground Capsicum Spices

J. B. MOSTER and A. N. PRATER, Gentry Division, Consolidated Foods Corporation, Los Angeles, Calif.

11:45—141. Sterilization of Cucumbers for Studies on Microbial Softening

REESE H. VAUGHN and CHARLES W. NAGEL, University of California, Davis, Calif.

12:00— VISIT YOUR EXHIBITS — LAST CHANCE!

THURSDAY AFTERNOON — JULY 1

Section P (Continued)—Sunkist Board Room
Sunkist Building, 707 W. Fifth Street

Citrus Concentrates

Chairman: W. R. ROY
Minute Maid Corporation, Plymouth, Florida

2:00—**142.** Algebraic and Graphic Solutions of Mixing Problems Involving Adjustment of Total Solids and Ratio of Solids to Citric Acid in Fruit Juices
WILLIAM KROEHLE, Mission Dry Corp., Los Angeles, Calif.

2:20—**143.** Frozen Grapefruit, Tangerine and Limeade Concentrates
M. K. VELDHUIS, W. C. SCOTT, U. S. Citrus Products Station, Winter Haven, Fla., and F. P. GRIFFITHS, U. S. Fruit & Vegetable Laboratory, Weslaco, Tex.

2:40—**144.** Concentrate of Lemonade
G. MANLEY COLE, Exchange Lemon Products Company, Corona, Calif.

3:00—**145.** Frozen Concentrated Pineapple Juice
M. L. LEVINE, C. E. MUMAW, R. G. LINXWILER and G. R. FELTON, Hawaiian Pineapple Co., Ltd., Honolulu, Hawaii.

3:20—**146.** Unit Servings of Concentrates in Flexible Films
E. R. FEHLBERG and H. T. HOLBROOK, Standard Packaging Corp., New York, New York.

3:45—**147.** Packaging of Frozen Citrus Concentrates
D. W. RIESTER and T. B. AYRES, American Can Company, Los Angeles, Calif.

4:05—**148.** The Transportation of Frozen Citrus Concentrates
E. M. HARVEY and W. H. REDIT, Horticultural Laboratory, United States Department of Agriculture, Pomona, Calif.

4:25—**149.** Use of Consumer and Trade Samples in Projecting Citrus Marketing Data
S. G. BARTON and STANLEY WOMER, Market Research Corporation of America, New York, N. Y.

4:45—**150.** Citrus By-Products and Derivatives
W. E. BAIER, Sunkist Growers, Ontario, Calif.

THURSDAY AFTERNOON — JULY 1

Section Q (Continued)—Edison Auditorium
Edison Building, 601 W. Fifth Street

Recent Basic Investigations in Food Science

Chairman: AKSEL G. OLSEN
General Foods Corporation, Hoboken, N. J.

2:00—**151.** Newer Concepts of the Role of Fats and the Essential Fatty Acids in the Diet
H. J. DEUEL, JR., University of Southern California, Los Angeles, Calif.

Discussion Leader:
ERNEST GEIGER, Van Camp Sea Food Company, Terminal Island, Calif. and Medical School, University of Southern California, Los Angeles, Calif.

3:00—**152.** Role of Antibiotics in Animal and Human Nutrition
E. L. R. STOKSTAD, Lederle Laboratories Division, American Cyanamid Co., Pearl River, N. Y.

Discussion Leader:
J. C. LEWIS, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

4:00—**153.** Recent Advances Contributing to the Stability of Foods
W. O. LUNDBERG and J. R. CHIPAULT, Hormel Institute, University of Minnesota, Austin, Minn.

Discussion Leader:
M. L. ANSON, Lever Brothers, Edgewater, N. J.

THURSDAY AFTERNOON — JULY 1

Section R (Continued)—Renaissance Room
Biltmore Hotel

Food Engineering Symposium

Chairman: CURTIS E. MAIER
Continental Can Company, Inc.
Chicago, Illinois

2:00— Introduction
CURTIS E. MAIER, Continental Can Company, Inc., Chicago, Ill.

2:05—**154.** Engineering Aspects of Food Preparation in the Canning Industry
ALAN RICHARDSON and BRUNO PILORZ, California Packing Corporation, San Francisco, Calif.

2:30—**155.** Evaporation in the Production of Major Food Products
VERNON C. PRASCHAN, Clinton Foods, Inc., Auburndale, Fla.

3:00—**156.** Engineering Aspects of Food Packaging
LAURENCE V. BURTON, Packaging Institute, New York, N. Y.

3:30—**157.** Instrumentation in the Modern Food Plant
Moderator: WILLIAM J. SCARLETT, Minneapolis-Honeywell Regulator Company, Philadelphia, Penn.

Application of Measurement Principles in Instrumentation
ALVIN J. FINK, Taylor Instrument Company, Los Angeles, Calif.

Types of Instruments and Their Application
LYLE M. RICHARDSON, Food Industries Division, The Foxboro Company, Foxboro, Mass.

What's Ahead for Instrumentation in Food Industries
ERNEST C. CLEMENT, Mars, Inc., Chicago, Ill.

THURSDAY AFTERNOON — JULY 1

Section T—Biltmore Conference Room 1

Research Papers—Fish and Meat

Chairman: M. J. COPLEY
Western Utilization Research Branch, U.S.D.A.
Albany, California

2:00—158. Studies on the Micrococci of Market Fish
S. E. HARTSELL, Purdue University, West Lafayette, Ind.

2:20—159. Observations on the Refrigerated Storage of Such Fish as Tuna, Sardines and Mackerel on Land and at Sea
LIONEL FARBER, University of California, San Francisco, Calif.

2:40—160. Antibiotics as Aids in Fish Preservation
LIONEL FARBER, University of California, San Francisco, Calif.

3:00—161. Discoloration of Packaged Fresh Red Meat and Its Relationship to Film Oxygen Permeability
ARTHUR H. LANDROCK and GEORGE A. WALLACE, Olin Industries, Inc., New Haven, Conn.

3:20—162. The Preparation and Storage Stability of Freeze-Dried Beef
L. W. REGIER, M. R. EMERSON, A. L. TAPPEL, A. CONROY and G. F. STEWART, University of California, Davis, Calif.

3:40—163. Amount and Character of Connective Tissue as it Relates to Tenderness in Beef Muscle
R. L. HINER, U. S. Department of Agriculture, and E. E. ANDERSON and C. R. FELLERS, University of Massachusetts.

4:00—164. The Nature of Certain Quality Attributes in Meat as Revealed by Infusion
V. R. CAHILL, L. E. KUNKLE, EUGEN WIERBICKI and F. E. DEATHERAGE, The Ohio Agricultural Experiment Station and The Ohio State University, Columbus, Ohio.

4:20—165. Water-Holding Properties of Beef
B. R. SURI and H. W. SCHULTZ, Oregon State College, Corvallis, Ore.

4:40—166. Temperature Distribution Patterns During Processing of Beef at High Retort Temperatures
HENRY HURWICZ, Trane Company, La-Crosse, Wisconsin and ROBERT G. TISCHER, Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill.

THURSDAY AFTERNOON — JULY 1

Section U—Biltmore Conference Rooms 3 and 4

Research Papers—Fruits

Chairman: J. B. MOSTER
Consolidated Foods Corporation, Los Angeles, California

2:00—167. Cold Process Jellies and Marmalade
R. L. HANDWERK and W. CARSON [illegible], Kraft Foods Company, Research Laboratories, Glenview, Ill.

2:20—168. Development of a New Concept for Processing Fruit Jelly
W. J. HOOVER, A. I. NELSON and M. P. STEINBERG, University of Illinois, Urbana, Ill.

2:40—169. Studies on Removal of Thrips from Cane Berries Intended for Processing
J. E. BREKKE, Fruit and Vegetable Products Laboratory, U.S.D.A., Puyallup, Washington, C. C. NIMMO and H. A. SWENSON, Western Utilization Research Branch, U.S.D.A., Albany, Calif., C. E. SAMUELS and J. R. BROCK, Oregon State College, Corvallis, Ore.

3:00—170. Mold Counting as a Means of Evaluating Efficiencies of Fruit Washing Techniques
RICHARD D. HAYNES, Monsanto Chemical Company, Dayton, Ohio and J. ORVIN MUNDT, University of Tennessee, Knoxville, Tenn.

3:15—171. Volatile Flavor of Strawberries. I. Identification of the Carbonyls and Certain Low Boiling Substances
K. P. DIMICK and BENJAMIN MAKOWER, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

3:30—172. Concentration of Strawberry Juice
L. H. WALKER, G. K. NOTTER, R. M. McCREADY, and D. C. PATTERSON, Western Utilization Research Branch, U.S.D.A., Albany, Calif.

3:45—173. A Study of Color Change in Stored Apple Juice Concentrates
E. C. DRYDEN, M. L. BUCH, and C. H. HILLS, Eastern Utilization Research Branch, U.S.D.A., Philadelphia, Penn.

4:00—174. Factors Influencing the Texture of Frozen Cultivated Blueberries
E. E. ANDERSON and W. B. ESSELEN, University of Massachusetts, Amherst, Massachusetts.

4:15—175. The Use of Fresh Fruit Maturity Factors to Predict the Quality of Canned Italian Prunes
ROBERT C. WILEY, University of Maryland, College Park, Maryland, and OLIVER J. WORTHINGTON, Oregon State College, Corvallis, Ore.

4:30—176. The Translocation of Sugars and Water in Canned Fruits
EDWARD ROSS, State College of Washington, Pullman, Wash.

4:45—177. Processing Characteristics of Texas Grapefruit. I. Color and Maturity Studies of Ruby Red Grapefruit
BRUCE J. LIME, THOMAS S. STEPHENS, and FRANCIS P. GRIFFITHS, U. S. Fruit and Vegetable Products Laboratory, Southern Utilization Research Branch, U.S.D.A., Weslaco, Tex.

ABSTRACTS

1

THE ROLE OF RESEARCH IN SOLVING RAW PRODUCT PROBLEMS OF THE PROCESSOR

Scheduling Plantings and Predicting Harvest Maturities for Processing Vegetables

H. L. SEATON
Agricultural Development Section, Research Division
Continental Can Company, Inc.
Chicago, Illinois

To make the most economical use of labor and equipment in the vegetable processing industry, a steady flow of raw products from field to factory is essential. Crop control programs, greatly affected by fluctuations in weather, must be adjustable for sudden changes. Plant growth and development is controlled by many interreacting environmental factors but, of these, temperature is by far the most important. Research on temperature effects in the late 1920's and early 1930's gave rise to the effective accumulated heat unit technique which recently has been widely adapted by many canners and freezers of peas, sweet corn, and other vegetables. This paper reports the basic research on which the heat unit method is based, the working details involved and the merits and limitations of the technique. Field departments as well as management have found it to be a valuable tool in the spacing of plantings, the timing of insect and disease control programs, the predicting of harvest maturities, and the arranging for labor and supplies. Allied industries have found it useful in scheduling the manufacture and shipment of containers and other supplies.

Since only one growth factor—temperature—is considered, heat unit values in different areas and between seasons may be variable. Recent research is reviewed which offers explanations for some of the variations and certain corrections are suggested.

2

TEMPERATURES IN RELATION TO DECIDUOUS FRUIT PRODUCTION

DILLON S. BROWN
University of California
Davis, California

The growth of deciduous fruits from bloom to harvest is strongly influenced by the prevailing temperatures. Correlations between temperature and fruit development are high enough to permit the prediction of the time of harvest and earlier critical points in the growth of the fruit. For example, the beginning of apricot harvest is predictable with an accuracy of plus or minus 3 days about 70% of the time.

Work with harvest prediction has also led to the derivation of the apparent efficiencies of temperatures in fruit development and a better understanding of the relative effectiveness of different temperatures. The apparent efficiencies of temperatures in promoting apricot fruit development increase from a minimum at 40° F. to a maximum at about 72°, and then decrease such that at 105° F. the efficiency is about 33% of optimum.

The use of temperature data in the prediction of earlier stages of fruit development is illustrated in the prediction of the *reference date* for cling peaches. *Reference date* is arbitrarily defined as a date 10 days after the pits of cling peaches begin to harden. It is important because the size of peaches at reference date is highly correlated with the size at harvest, and proper fruit thinning at about reference date encourages the development of satisfactory harvest size. In addition, because the length of time from reference date to harvest is reasonably uniform year in and year out, prediction of reference date also serves as a prediction of the beginning of harvest. The prediction of reference date is of practical importance mainly, however, in that it enables the cling peach industry, grower and processor, to be prepared to survey the cling peach crop at a critical period, to adjust the crop through thinning, and to begin early preparations for harvesting and processing the crop.

3

THE DEVELOPMENT OF NEW VEGETABLE VARIETIES BY PLANT BREEDING

ALLEN TROTTER
Associated Seed Growers, Inc.
Milpitas, California

The contribution of plant breeding to the solution of raw materials problems of the processing industry is discussed in broad terms. It is emphasized that plant breeding can supply a potential but that to reap the full benefit from the potential it is necessary to provide proper cultural practices. As greater uniformity is developed in vegetable varieties, the range of environment and cultural conditions for satisfactory development is narrowed. The methods used in development and evaluation of new varieties are discussed with particular emphasis on the problems of the food processing industry, based upon factors of yield, economic processing, and consumer acceptance.

4

PROBLEMS IN HANDLING RAW COMMODITIES IN FOOD PROCESSING PLANTS

D. G. SORBER
U. S. Department of Agriculture
Agricultural Research Service
Western Utilization Research Branch
Albany, California

A number of raw-material-handling problems in fruit and vegetable processing plants are reviewed, and efforts of various agencies to solve these problems are discussed briefly. Several of the problems to be mentioned are: *Containers*—Treatment of berry hallocks to insure clean, mold-free containers for berries. *Storage*—Cold Storage of peaches and pears to extend the processing season. Freezing storage of berries to permit year-round processing. *Conditioning practices*—Chilling sour cherries in ice water to increase firmness. Ethylene treatment of pears to increase rate and uniformity of softening. *Maturity quality sorting*—Brine separation of mature Lima beans. Electronic sorting of sweet corn as a possibility. *Cleaning*—Black "ends" on cut beans due to inadequate washing prior to snipping and cutting. Use of detergents in removing thrips and mildew from cane berries and aphids from broccoli. Froth flotation for removal of foreign material from peas, corn, and berries. *Peeling*—Possible innovations in peeling fruits and vegetables. *Pitting*—New method for pitting cling peaches. *Rapid handling*—The urgent need is stressed for the rapid handling of raw materials when they reach prime condition for processing to insure the preservation of top quality.

5

RELATION OF NITROGEN CONTENT OF THE MUST TO COLLOIDAL STABILITY OF THE WINE

ANDRE TCHELISTCHEFF, DIMITRI TCHELISTCHEFF, and
JOSEPH E. HEITZ
Beaulieu Vineyards
Rutherford, California

Lower nitrogen content grape musts produce a wine with greater colloidal stability than a similar wine made from must of higher nitrogen content. The nitrogen content of musts was found to vary with variety and the region where grown. Treatment with pectic enzymes effectively lowered the nitrogen content of a given must with resultant greater colloidal stability of the young wine.

6

COMBINED METHOD FOR HEAT AND COLD STABILIZATION OF WINES

CHARLES B. HOLDEN, JR.
Peralta Wine Company
Fresno, California

When a bentonite-gelatin fining procedure was used prior to the cold stabilizing process, it resulted in wines that remained clear when exposed for 16 hours to 140° F. and one week to 25° F. The amount of gelatin used was relatively small, being

approximately 2-4% of the bentonite. Laboratory studies concerning the effect of temperature on bentonite-gelatin fining were carried out at 20-25° F., 40-45° F., 60-65° F., and 80-85° F.

7

COLLOID CHEMISTRY OF COPPER CASSE

A. LUKTON and M. A. JOSLYN
Department of Food Technology
University of California
Berkeley, California

The formation of copper casse in white table wines was followed by measuring changes in redox potential and turbidity. The effect of pH, temperature, exposure to sunlight, and changes in concentration of copper, iron, sugar, alcohol, tannin, organic acid and phosphate on rate and extent of clouding was determined. Similar data were obtained on the course of clearing on exposure to air. The copper content of the insoluble material formed was measured at several stages of cloud formation and electron microscopic photographs of the sediment were obtained during formation and solution of the insoluble material. The kinetics of clouding are discussed in terms of the 3 theories for the mechanism of casse formation (colloidal cupric sulfide, cuprous sulfite, and copper protein formation).

8

THE INFLUENCE OF pH AND TOTAL ACIDITY ON THE STABILITY OF SHERRY WINE

RAUL DE SOTO
Roma Wine Co.
and
HANS WARKENTIN
The Twining Laboratories
Fresno, California

Experiments in the laboratory confirmed later on a plant scale have shown that sherries, which under usual conditions yielded a calcium haze or precipitate, were stabilized after adjustment to a definite pH.

9

STABILIZING APPLE WINE WITH ENZYME

H. Y. YANG
Food Technology Department, Oregon State College
Corvallis, Oregon

An enzyme preparation of glucose oxidase and catalase has been used to stabilize apple wine by the removal of oxygen after completion of fermentation. The treated wine was unpasteurized and unsulfured with a pH of 3.6 and an alcohol concentration of 12% by volume. Stability was measured by the volatile acid development. It was found that the development of volatile acids in the wine was retarded with an enzyme content of 0.1%, while further development was completely stopped by a content of 0.15%. No objectionable flavors were observed, and discoloration was so slight that it showed no appreciable difference from the natural browning of the untreated wine.

10

SULPHUR DIOXIDE—ITS IMPORTANCE IN HELPING MAINTAIN STABILITY IN WINES

E. C. SKOFIS
Italian Swiss Colony
Clovis, California

Visual observation and SO_2 analysis were made on wine shipment shelf samples stored for periods of 3 to 5 years. It was found that the SO_2 content of the wines which remained brilliant was 65 p.p.m. or higher, whereas those wines which became hazy contained from 25 to *nil* p.p.m.

11

THE LACTIC ACID BACTERIA AND STABILITY OF CALIFORNIA WINES

REESE H. VAUGHN
Department of Food Technology, University of California
Davis, California

As a group the lactic acid bacteria have caused most of the bacterial spoilage of California wines. Four commonly recognized species, *Lactobacillus brevis*, *Lactobacillus hilgardii*, and *Leuconostoc mesenteroides* spoil musts or table wines. *Lactobacillus trichodes*, which does not grow in musts, is the only species presently known to spoil California dessert wines. The characteristics of these bacteria, their activities in musts and wines, and methods for their control will be discussed.

12

BOTTLE STABILITY VS. COMPOSITION OF WINES

J. H. FESSLER
Berkeley Yeast Laboratory
Berkeley, California

Wines are susceptible to clouding from numerous causes. The most frequent causes are microbial, oxidative, metal, colloidal and tartrate precipitation. A number of samples of bottled wines of both dessert and table type (whose history is known), have been held in storage for up to 5 years. Their organoleptic condition at the expiration of the storage period is evaluated in relation to their chemical analysis before and after storage.

13

TECHNOLOGICAL PROBLEMS IN PREPARATION OF SPECIAL PURPOSE FOODS

H. W. SCHULTZ
Food Technology Department, Oregon State College
Corvallis, Oregon

Because special purpose foods are designed to satisfy particular requirements of those who consume them, their manufacture may demand radical departures from the usual techniques of food manufacture. The procedures used are for either of two purposes:

1. Giving the food a special form, or,
2. Giving it a special composition especially suited to the need.

The equipment and procedures for making these special foods from meat, milk, vegetables, and cereals are discussed. Process and quality control aspects are presented from the standpoint of adaption to the technical procedures as well as the intended purpose of the food.

14

PRESENT NEEDS FOR SPECIAL PURPOSE FOODS IN MEDICAL DIETS

TELFER B. REYNOLDS
University of Southern California, School of Medicine
Los Angeles, California

Although certain medical diets are neither widely enough applied nor of such unquestioned value as to warrant the development of special foods by industry, there are at least 4 dietary modes of therapy established on a sound basis, with wide application and a firm future. Special purpose foods contribute greatly to the successful application of these diets and further development of foods along certain lines should prove both profitable to the manufacturer and helpful to the medical profession. The practical contribution of the food industry has been in the provision of reasonably palatable substitute foods from which some forbidden ingredient has been removed. Doctors have found this an easier approach to dietary treatment than the changing of firmly entrenched eating habits.

Most authorities agree that the keystone of diabetic therapy is the proper balancing of carbohydrate and insulin intake towards the avoidance of hyperglycemia and glycosuria. This usually involves moderate carbohydrate restriction and the prohibition of many of the tastier portions of the menu, conditions which too often fail to prove completely acceptable to our patients. The increasing provision of low calorie desserts, canned fruits, and sweets made possible by the use of calcium cyclamate has been very helpful. More products of this sort are needed, plus some sort of low calorie flour substitute for baking. It seems unlikely that the oral use of other carbohydrates such as fructose will prove to be of any value.

In the obese, dietary efforts at weight reduction are often

doomed by their unusually strong appreciation for palatable foods. Increased use should be made of products already developed such as the low calorie carbohydrate substitutes of the diabetic diet. A low calorie or non-metabolizable substitute for flour, or for such high fat foods as butter, cream, cooking or salad oil would have obvious application. The success of such a product would be entirely proportional to its palatability.

Though the problem of the importance of exogenous cholesterol is still unsolved, it seems likely that there will continue to be a strong demand for low cholesterol foods. With this substance there is some hope that its specific inactivation in foods can be achieved or that its absorption from the gastrointestinal tract can be prevented. Failing this, the selection from food products of variants that are naturally low in cholesterol offers a relatively inexpensive way of dealing with the problem.

Diets low in sodium are important in the treatment of heart failure, cirrhosis of the liver, nephrosis, and toxemia of pregnancy. Low sodium foods are indispensable in these diets and are becoming increasingly available. Low sodium milk is an important recent development and an increasing variety of low sodium canned foods are being sold. The most needed item is a satisfactory non-toxic salt substitute, preferably an organic compound that can be metabolized. More, and cheaper, low sodium items of all sorts are needed.

The use of special purpose foods could be greatly increased by advertising, both to the physician and the laiety, thereby reducing prices and financing further special food development.

15

PEDIATRIC FOOD PROBLEMS

ROBERT A. ULSTROM
Department of Pediatrics, School of Medicine
University of California
Los Angeles, California

The freedom which prepared infant foods allow mothers today is a fact greatly appreciated by pediatricians and mothers. Potentially, the time saved frees the mother to spend time with more important aspects of family life. The varieties of these foods leaves little wanting. Economy of them needs discussion as does quality, especially where processing, adding to, and deleting from the original material has an important role in the final product.

For the child who is not in good health, the dietetic problem is often difficult. It is becoming wide-spread practice to use the so-called "free" diabetic diet, for example. This term has many meanings, but often implies the child eats the same good diet that the family eats. Therefore, one may expect that these families may be seeking purchase of food which is not high in free sugar content and yet is acceptable to their taste for sweet foods. The available "dietetic" foods do not always satisfy these families. A similar problem applies to the child in need of a caloric supplement. The disguising of a quantity of fat is not easy, but would seem an efficient approach to this problem. In general, children who need caloric supplements also have weak appetites, and take the presently available supplements poorly. Again, the psychological effect of the entire family eating the same food seems a better approach than to offer the child these special foods as a medicine.

The adjustment of mineral content of milk has recently been undertaken in the manufacture of infant formulae. This has given the pediatrician products of altered Ca:P ratios and low Na content which are useful in a number of disease states. A more or less completely demineralized product is not available. A limited use of this type of formula base is a possibility. Salt flavor substitutes remain a problem.

Finally, the value of addition of vitamins, minerals, and other substances to manufactured products will be discussed.

16

PROBLEMS IN FEEDING OF OLDER PERSONS

ROBERT R. COMMONS
University of Southern California School of Medicine
and
Endocrine Clinic, Los Angeles County General Hospital
Los Angeles, California

The prevention or correction of nutritional problems in older persons will not be accomplished by "supplementation of the diet with a comprehensive vitamin-mineral preparation." In this area nutritional deficiencies *per se* are rare in patients seen by most physicians. Some psychological or medical derangement is the usual primary cause for nutritional imbalance of patients of any age. Correction of the primary ailment leads to spontaneous improvement in morale and this is reflected in rational food intake in most patients. In the aged the ailment may be obscured, especially if an endocrine disorder is present.

Apathy and irrational food habits improve dramatically when even minor deficiencies of thyroid or steroid hormones are corrected. The production of an inexpensive convenient packaged balanced meal which could be prepared as easily as tea and toast would be welcomed by many patients and physicians.

17

PROBLEMS IN PRACTICAL FEEDING OF DIETETIC FOODS

RUTH LITTLE
White Memorial Hospital
Los Angeles, California

There are an estimated thirty million dieters in the United States. Dietetic foods will be considered from the standpoint of the dietitian for the patient (dieter) 1. In the hospital. 2. In the home.

General suggestions and requirements for dietetic foods:

Chemical analyses of all dietetic foods should be required.

Informative labeling. Labeling must be accurate and specific. Without analysis and accurate labeling the food can be unusable for dietitians and dangerous for patients.

Standard recipes for home and institutional use. These should be simple and easy to prepare and avoid ingredients difficult to obtain.

More extensive advertising. Catalogs or bulletins should be distributed to dietetic and medical profession giving detailed information regarding dietetic food items, and where products may be obtained.

Ease of procurement. Many products need to be made more readily available. There should be less differential in price between dietetic and similar non-dietetic foods.

There is need for *variety of palatable substitutes* for basic foods, modified for specific purposes. Product should retain flavor, color, and texture. Palatability of some items may be improved through use of herbs, spices, and flavorings. Consumer must like the product and want to eat it.

Suggestions: Importance of the ease of preparation will be stressed—convenient completely cooked frozen foods, precooked dietetic frozen meals, easy to prepare mixes, etc.

Nutritional value is important and must not be overlooked.

Specific suggestions of dietitians in various localities which have not been previously included will be presented.

18

SPECIAL PURPOSE FOODS (FRUITS AND VEGETABLES)

C. A. WEAST
Flotill Products, Incorporated
Stockton, California

The limitations and possibilities for special purpose foods of fruit or vegetable origin depend primarily upon the need for such products and their acceptance. The acceptance can largely be determined by the success with which one can duplicate the appearance, texture and flavor of the conventional item while at the same time make these changes in calorie, sugar, sodium, etc. content which may be desirable. General considerations in the development and manufacture of a number of products will be discussed. The important position occupied by the American Medical Association and the Food and Drug Administration will be considered.

19

THE METABOLISM OF SORBITOL AND MANNITOL

ARNE N. WICK
Scripps Metabolic Clinic
La Jolla, California

There is considerable information indicating that fructose is metabolized by a route different from that of glucose. Since sorbitol has been shown to be converted to fructose by the liver, its metabolism should be comparable to fructose. This has been examined by comparing the fate of radioactive sorbitol and fructose after administration to alloxan-diabetic rats. The results will be reported.

The metabolic fate of radioactive mannitol has also been

examined in normal animals. It was found that the route of administration exerts a profound effect on its metabolism. When given by the oral route, 50% of the mannitol is oxidized. However, when administered parenterally, the alcohol is excreted almost quantitatively.

20

EFFECTS OF IODIZED SALT IN PROCESSED FRUITS AND VEGETABLES

N. KOJIMA and H. D. BROWN
The Ohio State University Institute of Nutrition and Food Technology
and
Department of Horticulture
Columbus, Ohio

The work reported herein was undertaken to determine the effects of iodized salt on the quality of certain processed fruits and vegetables. Products were chosen in which salt was used in considerable amounts. They were canned tomato juice, sauerkraut, both bulk and canned, canned whole kernel corn, canned green beans, and pickled olives.

Summary of Results

A. Tomato juice
   1. There was no significant difference in flavor and odor due to the presence of iodized (.01%KI) or iodated salt (.015%). Even 10 times as much I_2, KI or KIO_3 with or without nitrate or nitrite could not be identified by taste or odor in the tomato juice.
   2. Out of 8 tasters, only one could detect a difference in flavor in tomato juice to which 12.5 p.p.m. of iodine (25 times usual concentration of iodine in iodized salt) had been added. Two could detect iodine added at the rate of 25 p.p.m.
   3. There was no significant difference in the color (a/b ratio) as measured objectively by the Hunter Color and Color-Difference Meter.
   4. There was no significant effect of iodized salt, free iodine, and nitrate (0.01% concentration) on vitamin C content, but added nitrite (0.01%) destroyed about half of vitamin C (9.73 to 10.63 mg/100g for 3 nitrited lots as compared to 22.5 to 40 mg/100g for 8 remaining treatments).

B. Sauerkraut (Bulk)
   1. There was little difference in the amount of acid expressed as lactic produced in fermentation by non-iodized and iodized salt or iodated salt.
   2. In bulk kraut there was no significant difference in flavor, texture, or color.

C. Canned green beans
   1. There was no significant difference between the control and iodized-salt-treated beans.
   2. There seemed to be little difference in color as evaluated by Hunter Color and Color-Difference meter.

D. Canned Corn
   1. There was no significant difference in taste or color between the control and iodized-salt-treated corn.

E. Pickled Olives
   1. There was no difference in flavor or color between the control and iodized and iodated lots.

21

CHLORTETRACYCLINE* AND THE CONTROL OF POULTRY SPOILAGE

A. RICHARD KOHLER, HARRY P. BROQUIST and W. H. MILLER
Lederle Laboratories Division, American Cyanamid Company
Pearl River, N. Y.

When whole eviscerated chickens or cut-up chickens were dipped in water containing 3 to 30 p.p.m. of chlortetracycline and stored at 40° F. such chickens remained fresh and edible for 7 to 14 days longer than untreated controls. Chlortetracycline was effective in increasing the shelf life of poultry meat because it was readily absorbed into the tissues in bacteriostatic amounts, and because the spoilage microorganisms that predominated in chicken are inhibited by this broad spectrum antibiotic. Bacterial counts of poultry meat treated with chlortetracycline showed from 100 to 1000 times fewer microorganisms per g. of tissue than did untreated controls. When poultry meat was treated with chlortetracycline, no evidence was obtained that strains of microorganisms develop that were resistant to chlortetracycline. Traces of chlortetracycline present in the tissues of the poultry were completely destroyed by a variety of common cooking procedures. This was true even when poultry meat was treated with 100 times as much chlortetracycline as was needed to prevent spoilage.

*The trademark of American Cyanamid Company for the antibiotic chlortetracycline is Aureomycin.

22

FLAVOR OF UNTREATED, OILED, AND THERMOSTABILIZED SHELL EGGS AFTER STORAGE AT 34° F.

SALLY FOSS, FRANCES CARLIN, and OWEN COTTERILL
Home Economics Research and Poultry Husbandry
Iowa State College
Ames, Iowa

One of the major problems in marketing shell eggs is the loss in quality which occurs during handling and storage. Oiling and thermostabilization have been used to retard this quality deterioration of eggs.

Flavor is one of the important criteria for quality in shell eggs. This investigation was concerned with flavor changes in untreated, oiled, and thermostabilized shell eggs stored at 34° F. A carefully selected and trained taste panel evaluated the flavor of scrambled and soft-cooked eggs at monthly intervals for 8 months.

Two hundred dozen shell eggs of similar initial quality (albumen height 5.5-6.0) were obtained from hens of known genetic history. Eggs to be oiled or thermostabilized were treated 18 hours after laying and placed in storage each week from May 14 to July 17, 1953. The experiment was so designed and eggs were treated and stored over a sufficient period of time to permit the sensory panel to compare, at the same tasting session, eggs stored different lengths of time.

The albumen index and Haugh units of all the eggs used in the study are reported. As the storage time increased, the flavor scores for all stored eggs were definitely lower. Under the conditions of this experiment, off-flavor was more noticeable in the white than in the yolk of the oiled or thermostabilized eggs when they were soft-cooked, whereas, in the untreated egg, the flavor of the yolk was scored lower than the white.

23

DESTRUCTION OF ENZYME ACTIVITY IN EGGS BY HEAT TREATMENT

OWEN J. COTTERILL
Iowa State College, Ames, Iowa
and
A. R. WINTER, H. C. COOK, and H. H. WEISER
The Ohio State University, Columbus, Ohio

Lysozyme, phosphatase and amylase activities of homogenized white and whole egg were reduced by temperatures and times used for thermostabilization of shell eggs and pasteurization of liquid egg products. Their determination offers possibilities for detection of the heat treatment, if any, to which shell or liquid eggs have been subjected.

24

THE CONTROL OF BACTERIA IN SHELL EGGS

A. R. WINTER and PATRICIA SHIELDS
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Testing layers for *Salmonella* infection, production of clean eggs, holding them for a short time and in a cool place, washing with a combination detergent-sanitizer, quick drying without rinsing, and thermostabilization during agitation in oil for 2 minutes at 148 to 156° F. are practices that have resulted in eggs of good keeping quality and low bacterial content.

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THE EFFECT OF HIGH TEMPERATURE STORAGE ON THE CONTENT OF SALMONELLA AND THE FUNCTIONAL PROPERTIES OF DRIED EGG WHITE

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A number of reports have shown that dried egg products contain organisms belonging to the genus *Salmonella*. A preliminary report from this laboratory has shown that egg white can be freed from these organisms by storing the product at elevated temperatures in the dried state. The present study was undertaken to determine to what extent certain moisture levels affected the microbiological populations introduced in the product. Also, the effect of moisture and temperature of storage on the functional properties was determined. Experimental lots of egg whites were inoculated with *Salmonella pullorum*, *S. oranienburg*, or *S. senftenberg* and then pan- or spray-dried. Temperatures used for storage were 50, 60, or 70° C. and moisture contents of albumens were 1.5, 3.0, 6.0 or 12%. Turbidity, pH, solubility, and whip tests were determined. Results show that it is possible to eliminate numbers of *Salmonella* from dried egg white and still maintain the functional properties of the product.

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DETERMINATION OF SOLUBILITY INDEX OF SPRAY DRIED EGGS

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A simple and rapid method for determining the solubility index values of spray dried whole egg is described. The method involves 4 main steps.

1. Dispersion of egg solids in 0.9% saline solution.
2. Centrifugation of saline-insoluble solids.
3. Precipitation of saline-soluble and colloidal fraction with Esbach Reagent.
4. Centrifugation of Esbach precipitated solids and reading of volume of the precipitate as solubility index.

In addition to an accurate tachometer, this method requires only routine laboratory equipment and easily obtainable reagents. Stabilized and non-stabilized egg powders lend themselves equally well to solubility index determinations by this procedure.

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ACETOGLYCERIDES—NEW FAT PRODUCTS OF POTENTIAL VALUE FOR THE FOOD INDUSTRY

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Substitution of acetic acid for a portion of the fatty acids normally combined in fats and oils can result in unique products. Some of these, unlike ordinary plastic fats, can be simultaneously nongreasy and plastic over the temperature range of about 0° to 45° C. Others can resemble ordinary edible oils and yet have melting points as low as −20° C. and be more resistant to oxidation and polymerization.

The acetic acid-containing fats and oils, or acetoglycerides, can be prepared in several ways. Their melting point, hardness, and plasticity can be controlled within limits; that is, their properties can be tailored to some extent to meet a specific need. Amount of plasticity, resistance to changes in crystal structure on aging, resistance to hydrolysis, permeability to moisture and atmospheric gases, and other physical properties have been measured for various preparations.

The acetoglycerides appear to be well suited for a number of uses in the food industry, provided proof of edibility is obtained. Extensive feeding tests and other biological studies are now under way to provide this proof.

The higher-melting acetoglycerides (acetostearins) might be considered as coating materials for frankfurters, other processed meats, cheese, and similar food products, and as a moisture-resistant coating for raisins to be incorporated in breakfast cereals. Both high- and low-melting acetoglycerides might be used as a highly stable roasting oil for nuts.

Acetoglycerides containing a large proportion of combined oleic acid are being investigated in preparation of a special margarine-like spread for the armed forces.

Plastic wrapping materials in which acetoglycerides are used as plasticizers may have some special uses in the packaging of foods.

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DIFFERENCE IN HEAT STABILITY OF THE PHOSPHATES CAN SERVE AS A TEST FOR ADULTERATION OF RAW MILK WITH HEATED MILK

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Whereas it is easy to ascertain the presence of raw milk in pasteurized milk by the use of enzymatic tests (phosphatase, Schardinger), there is no sure test for the detection of pasteurized milk present in raw milk. The method developed by Babad *et al.* for the detection of heated milk in milk products is rather difficult and applies only to milk heated at high temperatures such as high heat type milk powders. Our new test gives satisfactory results even with mild heat treatments of the milk; it is based upon the fact that the stability of the milk serum to heat is affected by pasteurization. When milk is heated even to mild temperatures such as 62° C. (the usual pasteurization treatment), its pH is lowered and a new equilibrium is established between monocalcium and dicalcium phosphates. This new equilibrium results in an increase in stability of the pasteurized milk serum over the raw milk serum. The stability of the serums is measured either by the time needed by such serums to give precipitate when heated in a constant temp. water bath at 70° C. or by the amount of precipitate and the turbidity of the supernatant liquid.

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THEORY AND APPLICATION OF CONTINUOUS PRESSURE FILTRATION TO THE EXTRACTION OF IRISH MOSS

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In the processing of Irish Moss to obtain extracts having viscosity and gel strength properties, the basic steps are digestion and filtration followed by evaporation and drying of the filtrate. Data were taken on experimental equipment to evaluate the feasibility of continuous pressure filtration to replace batch methods and thereby lower operating costs, obtain the advantages of continuous processing, and further increase product quality.

Filtration of the water extract slurry presents a formidable problem in that the liquor is highly viscous, the extracted solids are gelatinous and slimey and a high filtrate clarity is required. Large amounts of filter-aid are required in batch filtration to attain an operable condition. Accordingly, a complete experimental study was performed on: (1) The influence of viscosity, pressure drop, filter-aid concentration, and degree of preliminary moss grinding on filtration rates. (2) Filter media requirements for filtrate clarity specifications. (3) Ease of filter cake removal.

It was proven that filtration rate was inversely proportional to the square root of the viscosity and directly related to approximately the square root of pressure drop. Filtration rates were appreciably increased by coarser grinding particularly at lower filter aid levels. Filter-aid requirements for production equipment were estimated to be only 25% of those required for batch filtration. Acceptable filtrate clarity and cake removal was obtained by use of a fine mesh Orlon filter media.

Included in the paper is a detailed description and flow sheet of the complete filtration station that would be required for the process. Special emphasis was placed on automatic control, maintenance of optimum operating temperature in the pressure shell gas space, and sanitary construction.

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THE ANTIOXIDANT PROPERTIES OF NATURAL SPICES IN SIMPLE OIL-IN-WATER EMULSIONS

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The antioxidant properties of 32 spices have been evaluated in a simple biphasic oil-in-water emulsion system by the oxygen absorption technique. All spices stabilized the emul-

sions against oxidation. In general, the stabilizing effect of spices in emulsion systems was greater than in a single phase fat substrate and in baked products previously studied, and the order of effectiveness of the spices in the emulsion system is also different from that observed in the other substrates.

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THE ANTIOXIDANT PROPERTIES OF NATURAL SPICES IN FOODS

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Samples of 17 spices have been incorporated in mayonnaise, French dressing, and ground pork. The development of rancidity in these products has been studied by oxygen absorption and peroxide accumulation methods. Some of the spices studied appreciably increased the stability of these foods. The effectiveness of various spices in preventing oxidation of the fat component of these materials could not be predicted from results obtained with a plain fat, or a simple oil-in-water emulsion substrate.

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MAPLE SIRUP. VII. CONTRIBUTION TO THE CARBOHYDRATE CHEMISTRY OF MAPLE SAP AND SIRUP

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As part of the investigation of the source and composition of maple flavor, a study of the carbohydrates of maple sap and sirup was undertaken. The sap was collected by an aseptic technique and was free of microbial contamination. The sirup was of high grade quality made under commercial conditions. Ion exchange techniques were employed to separate out the neutral, carbohydrate portion of each material which was concentrated to a sirup under extremely mild conditions to minimize changes in the carbohydrates. These concentrates of the carbohydrates were fractionated by partition chromatography on cellulose columns. The fractions were subsequently studied by paper chromatographic methods and enzyme hydrolysis. Comparison of certain sugars found in sterile sap was made with commercial sirups to show some definite changes in composition.

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MAPLE SIRUP. VIII. A SIMPLE AND RAPID TEST FOR THE ANALYSIS OF MAPLE SIRUP FOR INVERT SUGAR

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A simple, rapid, inexpensive, chemical method for the determination of invert sugar in maple sirup has been developed. The test has been designed for use by farmer-maple sirup producers and operators of small sirup processing plants who do not have technically trained personnel, for the selection of maple sirups having the optium concentration of invert for making maple cream and other confections.

The test is most applicable as a threshold test to identify sirups containing greater or lesser amounts of invert sugar than a certain percentage. It may also be used to determine the approximate percentage of invert sugar in sirups in the range of 1 to 6 percent with an accuracy of 1 percent.

The test is based upon the use of a simple commercially available reagent, which was developed for the determination of sugar in the urine of diabetic patients, and upon a series of fixed dilutions such that the different dilutions of the test sirup will contain either more than or less than a fixed amount of invert sugar. Adjacent dilutions, one yielding a negative and the other a positive test, will give values which bracket the percentage of invert sugar in the test sirup.

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A STUDY OF CERTAIN FACTORS AFFECTING THE GROWTH OF FLOR YEAST

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The Spanish sherry making process involves the use of certain film forming yeasts during the aging process. The yeasts are known in the industry as "flor" yeasts. In our investigation various microbial nutrients and growth promoting substances were added to sterile dry white wine of approximately 14.6% alcohol content by volume and the resulting crops of yeast were recovered, dried, and weighed at regular intervals.

Yeast autolysate caused the greatest increase in yeast crop. Asparagine, urea, glycine, peptone, ammonium salts, and aspartic acid also increased the crop. Dextrose, sucrose, potassium, phosphorus, biotine, inositol, thiamine, and a considerable number of other substances had no effect. Fe salts, ascorbic acid, beta-alanine, and riboflavin exerted an inhibiting effect on the flor yeast.

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VARIATION IN FLAVOR JUDGMENTS IN A GROUP SITUATION

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Food evaluation by the panel method can at the present time be divided into two general approaches. The first consists of the round table or modifications thereof. The second method involves individual judgments, independently arrived at. Although it has frequently been assumed that the two methods yield comparable results, no systematic study of this question has as yet been made.

The present study was designed to investigate the response differences obtained by the two methods. Various food products were presented to panel members under the two conditions, and their effects on preference, difference and absolute ratings were assessed. Implications of these results for food technology are discussed.

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DETERMINING THE SIZE COMPLIANCE OF FOODS

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The difficulty which food testing laboratories experience in obtaining reproducible results for determining size compliance of foods is a control problem of long standing. A study indicates that the problem stems not only from the complex nature of foods, but also from a lack of readily accessible and authoritative information specifying methods for performing size compliance tests. In some cases, no size requirements whatever are specified, and therefore, no method is used. In many cases, where size compliance is required, it appears that the only existing procedures are trade methods passed along by word of mouth. For certain foods where specific size measurement instructions are available, their ramification in various printed specifications and inspection procedures makes it difficult for the analyst to integrate the material into a usable form. The objective of this paper is to provide — in concise, readily accessible form — exact methods for performing size tests for the more common foods with size compliance requirements, and for those foods without size requirements which fall into this category. Methods presently available, which are considered satisfactory, are given and correlated with a list of familiar foods tested for size. Proposed methods are given in cases where present methods are considered inadequate or entirely lacking. Size determination is defined, and standards are specified for sieves, screens, calipers, rulers, and measuring containers. Simplified methods for indirect measurement by count per container volume are specified for many foods. A brief history of the size estimation of foods, origin of sieves, and development of measuring devices is also included.

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THE FOOD TECHNOLOGIST, THE MEDICAL OFFICER, AND FOOD ACCEPTANCE TECHNIQUES IN THE DEVELOPMENT OF FOOD ITEMS FOR HOSPITAL AND CLINIC PATIENTS

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The many new and important developments of special dietary foods for the hospital and clinic patient have created a need for the measurement of the effects of added or altered ingredients on

flavor changes and taste acceptance while meeting both the physiological needs of the patient and the regulations of the American Medical Association and of food and drug standards.

In order to help bring together food technology and medical science in these developments, standard food acceptance techniques are required. For this purpose a *7-Phase Acceptance Test Method* is described and proposed.

In essence the method represents the projection of order of merit, differences, preferences, rate of acceptance, lingual and affective responses, and past experience upon an hedonic tone scale for the multiple measurement of both food and judge.

The degree to which confidence and use-value can be derived from this *7-Phase Acceptance Test Method* is demonstrated by a series of separate and repeated tests on the same and on different items by a group of 40 respondents. Only 3 out of 11 nationally distributed protein concentrates were considered acceptable. The record represents a diorama of responses which makes it possible to demonstrate the reasons for different degrees of acceptance or rejection. Some of the problems are for the food technologist to resolve, and others are for the medical officer. Examples are given and are described.

Though application of the method is demonstrated in the field of clinical medicine and food therapy, the method itself is generally applicable to all areas of food acceptance research and development.

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CONSUMER WINE-PREFERENCE METHODOLOGY STUDIES AT CALIFORNIA FAIRS

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For 3 years consumer reaction to several types of wine and to variations in wine composition has been observed by means of samples and questionnaires presented to thousands of visitors to two large California Fairs. Although much incidental knowledge has been gained about consumer preferences in wines, the main purpose of the experiment, has been to investigate the methodology of this type of consumer survey, to learn how to interpret the data obtained, and to ascertain its reproducibility. Several modifications in design of the experiment, type of questionnaire, and method of scoring have been tried. Some interesting data have been obtained indicating biases for the middle sample in the triangular test and for the first sample in the paired comparison test.

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DEVELOPMENT OF A SCALE FOR MEASURING SOLDIERS' FOOD PREFERENCES

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Research was undertaken to determine the characteristics of a successive interval rating scale which would be optimal for measuring food preferences of soldiers in a field situation. Groups of soldiers at a number of different Army posts participated in a series of questionnaire studies. The purpose of the first survey was to select a number of descriptive words or phrases, each having a common meaning for an Army population when used to express food preferences, which would be suitable for anchoring the intervals of the scale at different levels of preference. A second survey was designed to determine the length of scale (number of successive intervals) which would be optimal as judged by the criteria of time required for completion, reliability, and amount of information transmitted. A third survey tested the effects of eliminating the middle, or neutral, category, and using an unbalanced scale.

Striking differences were found among various descriptive words and phrases in regard to scale value or level of preference implied and dispersion value or ambiguity. From these results it was possible to select phrases which were relatively unambiguous for the Army population and which were suitably spaced along a preference continuum. The second and third survey showed that: (a) both time required by respondents to complete questionnaires and reliability were relatively invariant over all scales tested; (b) the amount of information which may be obtained from a scale depends upon its length, its balance, and the presence or absence of a neutral category.

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COMPARATIVE SENSITIVITY OF RATING SCALE AND PAIRED COMPARISON METHODS FOR MEASURING CONSUMER PREFERENCE

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There appears to be little or no published evidence to support the oft-stated contention that measurement of preferences for foods by paired comparison is more sensitive to differences than is the rating scale method. On the other hand, much work in psychology on discrimination of differences has shown that the method of single stimuli or absolute judgment yields results comparable to paired comparisons.

An experiment was designed to determine the relative sensitivity of the two methods for consumer preference testing, by using a number of pairs of foods with large groups of consumers naive to the purpose of the experiment. Part of the foods had known differences such as the addition of monosodium glutamate, sugar, or other seasoning; for other pairs the differences consisted of a processing variable such as holding on a steam-table for different lengths of time so that the difference is definable only operationally.

For the ratings, a nine-point scale with descriptions ranging from *like extremely* to *dislike extremely* was used. All samples were coded, and the serving of the samples was randomized to avoid position errors. The paired preferences and scale ratings were itemized in an ABBA pattern to avoid time order errors. The session was then replicated on another day in order to obtain approximately 40 judgments of each type for each pair of foods.

The probability level, p, for each pair of foods, whether the difference was obtained by paired preference or by scale rating, was determined: (a) for paired preference from "Tables of the Binomial Probability Distributions"; (b) for rating scale by the t test by differences to account for correlation in the ratings then converting to probabilities; (c) by converting the scale ratings to paired preference scores, then entering the probability tables.

The foods selected gave a wide range of probabilities (from $p = 1.0$ to $p < 0.001$) that a true preference for one of the pair over the other existed. This was true whether the values were based on 20 judges, or 40, when the data for the same pair of foods from two sessions are combined.

For any pair of foods the expressed preferences yield p values that generally are of the same order of magnitude for both methods. In addition to the satisfactory sensitivity of the scale rating method, its other advantages are discussed.

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EFFECT OF PRIOR TESTS ON CONSUMER RESPONSE TO FOODS

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Examination of the results of a series of consumer-type tests conducted with a 9-point "like-dislike" scale has revealed conditions under which the ratings are not independent. Ratings given to samples of scrambled eggs were found to be influenced by previous testing of scrambled eggs differing in color, flavor, or texture. This influence occurred when two or more days elapsed between testing of samples as well as when the time interval was only a few minutes. Obviously, this lack of independence of ratings should receive attention in the design of organoleptic tests that require rating of two or more samples, and interpretation of the data obtained from such tests must take this fact into account.

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SINGLE PRODUCT OR PAIRED COMPARISON CONSUMER TESTS—WHICH SHOULD YOU USE?

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The studies reported cover a number of consumer tests in which the same product was tested using more than one method of evaluation. If the product to be tested is somewhat similar in quality and characteristics to a generally known product, a

paired comparison test appears to be more critical than a single product test as it brings out small differences. However, if a single product test is used, consumers tend to place slightly inflated values on the product. If the product to be tested has what appears to be easily recognizable superiorities, according to organoleptic testing, then a single test is somewhat more advantageous. Under this condition a paired comparison tends to inflate the value of the better product and deflate the value of the poorer product. A single test, therefore, gives a more accurate picture of the relative values.

Thus, product attributes, test objectives, and competitive situations largely determine the use of single or paired comparison consumer tests.

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A HOUSEHOLD AND A LABORATORY TYPE OF PANEL FOR TESTING CONSUMER PREFERENCE

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This paper deals with techniques for determining individual consumer preference for food products to be prepared in the home. A mail-away procedure is described, based on serving two coded samples of the product at regular meals on different days with separate questionnaires completed by each family member over 10 years of age. A carefully selected population of 400 representative families distributed country-wide is used. The completed questionnaires are analyzed in various ways in an attempt to determine the relative preference or acceptability of the two food samples. A second procedure involves side-by-side comparison of two samples by a panel of 25 to 50 individuals trained for judging many factors affecting consumer acceptance of all types of products but without bias-due-to-knowledge concerning the development or qualities of the products tested.

Data to be presented indicate that a population shows a relatively definite and consistent choice when differences between the samples are easily perceived as to form, color, texture, flavor, etc. When such differences are difficult to detect, preferences are about equally divided, indicating that either variant would be equally well received by the public. Results from such consumer tests become confusing and sometimes contradictory when the difference in one or more qualities is real but not readily perceptible to all judges. This traces in part to lack of an established measure of the degree of preference in such tests required to be significant. The usual statistical measure of confidence level is difficult to apply in evaluating consumer panel results. Preliminary findings indicate a general agreement between the two types of panels.

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INVESTIGATION OF FOOD PRODUCTS AT THE CONSUMER LEVEL

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Food processing companies face many problems when surveying their own and competitive products at the consumer level. Among factors which require careful attention are: (1) obtaining merchandise which is representative of that available to the average consumer; (2) selection of taste panel groups which will reflect consumer preferences; (3) maintaining an unbiased point of view in connection with label design, appearance, and other products and package characteristics.

The methods employed by Kraft Research Laboratories in conducting consumer surveys will be discussed. Survey work has been carried on over a period of years and a number of problems have come to light based on this experience.

Potential values which can be derived from such surveys as applied to food processing companies will be considered. Information of value to research, production, sales, and advertising departments of a company can be obtained through this type of approach.

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THE DEVELOPMENT OF SPECIAL RATIONS—AN APPLICATION OF SENSORY ANALYTICAL TECHNIQUES

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In recent years sensory analytical techniques have come to be important and powerful tools in the development of new products. It is possible to plan special rations that meet every known nutritional requirement, to combine basic materials in such a manner that these requirements are fulfilled, to make chemical, physical and other types of tests to verify predicted composition and, in some instances, to measure changes that occur during storage. There is, however, no method by which the palatability and general acceptability of special rations immediately after preparation or after extended storage periods can be measured except by those classified as sensory methods.

Some of these sensory methods have been extremely valuable in the development and study of special rations intended for use in civilian emergencies. This paper will demonstrate the application of such methods during the evolution of acceptable formulations and during the periods when the rations were being tested for storage stability.

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CANNING INDUSTRY INTEREST IN RECENT FOOD AND DRUG LEGISLATION

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The canning industry has had a long record of interest in Food and Drug Standards and in so called Food and Drug legislation generally. The industry was the first to come within the influence of the standards-making mechanism in 1938 and there are now more then 50 mandatory standards for canned foods. In these 16 years of standard making, while there have been no great changes in actual Food and Drug procedure, there have been evidences of efforts on the parts of both the Food and Drug Administration and industry to simplify procedure and reduce cost. Prominent evidence of this interest is found in the so-called experimental shipment of foods which do not conform to the existing standards. Another means of relief appears to be in sight in the Hale bill which provides that a mandatory food standard may be issued, amended, or even repealed without a public hearing where there is no controversial issue.

Since the beginning of Food and Drug and legislative interest in the broad "chemicals in foods" problem, there has been increasing interest on the part of interested groups toward control of pesticide residues in foods for human consumption. This part of the "chemicals" problem promises to shape up in workable fashion, probably through the passage of the Miller Bill which specifies that any fresh food will be adulterated if it contains any pesticide, unless they have either been exempted from a tolerance or a tolerance had been established under a new section to be added to the Act.

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THE MILLING INDUSTRY—ITS INTEREST IN FOOD AND DRUG ACTIVITIES AND LEGISLATION

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This industry, comprising producers of many kinds of cereal products such as flour, breakfast foods, pancake mixes, cake and cookie mixes, serves persons of all ages and is affected greatly by any trend in public opinion regarding health and nutrition. Since it is highly competitive, most manufacturers feel impelled to advertise heavily and to continually modify or change their products to meet public demand or to conform to advances in nutritional knowledge.

Consumers have been educated to demand purity, cleanliness, and good nutrition in their food products. A large portion of this education has come from the advertising of the manufacturers themselves, magazine articles inspired by activities and pronouncements of such groups as federal and state officials connected with the enforcement of Food and Drug laws. The National Research Council, the American Medical Association, the American Dental Association and others have also influenced public thinking in this field. The attitude of these various groups influences the activities of the cereal manufacturers to a great degree.

The place of governmental controls and some of their ramifications are discussed. These include grain inspection, definitions and standards of identity, label directions, and even package sizes, advertising claims and sometimes the inclusion of specific

ingredients. Additional legislation at the federal level has been proposed and the effect of this, if enacted into law, is discussed.

Although this subject directly impinges upon the daily life of every individual, there is a lack of appreciation upon the part of many as to the scope of present and proposed regulations, not only upon the cereal manufacturers but upon the public. Some suggestions are made regarding the positions which various interested groups might assume in the best interests of the public.

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THE PROGRAM OF THE FOOD PROTECTION COMMITTEE OF THE NATIONAL RESEARCH COUNCIL

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The Food Protection Committee, functioning under the Food and Nutrition Board of the National Research Council, has three general objectives in view: (1) To develop better criteria and methods for establishing the safety of chemical additives for foods. (2) To encourage the kind of research programs necessary to meet the criteria for safety developed by the committee. (3) To promote cooperation between industry and government in the development and control of chemical additives in foods.

In an effort to obtain factual information concerning the use of chemical additives in foods at the present time, the Food Protection Committee, with the cooperation of the food and chemical industries, has undertaken a survey of the number and quantity of chemical additives used in foods. The project has yielded valuable data that may be used to adduce responsible evidence concerning chemicals in foods, as well as to estimate the possible hazards and benefits to public health.

During 1954, the committee plans to review and elaborate its 1952 statement of basic principles involved in evaluating the safety of chemical additives for food use. Recommendations for research and testing programs for new additives will be formulated. The safety of certain intentional additives will be evaluated, those selected for study being chosen according to one or more of the following criteria: (1) The additive poses a well defined problem in relation to the development of basic principles. (2) The additive is widely used or its use is increasing in processed foods. (3) The additive presents some definite indications of significant biological activity related to its proposed use.

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TOXICOLOGICAL DETERMINATION OF SUITABILITY OF FOOD ADDITIVES

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It is a well established principle that proof must be available as to the harmlessness of a substance to be used as an additive to a food before the product containing it may be sold in interstate commerce. When there is no exact knowledge as to the chemical nature of the substance, it is necessary to carry out the following series of tests: (1) the determination of LD_{50}, (2) acute (6 weeks) tests to determine how much of test substance can be tolerated, (3) long term (2 years) growth studies in which the material is fed at a level of at least 100 times the maximum amount it will be incorporated in the diet, (4) an histopathological examination of tissues of animals which die during the course of the test as well as of the survivors, (5) determination of effect of test substance on reproduction and lactation. This can be accomplished best by the so-called "multigeneration" test and (6) the determination of any possible toxicity if the food containing the additive is subjected to any of the usual treatments used for preparing foods (frying, baking, boiling, etc.). The observer must assure himself by analysis or by other means that the material being tested is genuine. The U.S. Food and Drug Administration recommend that confirmatory tests be made on 2 additional species. Of the 3 species of animals used for the tests, one should be a non rodent. Evidence as to the extent of absorption and method of excretion of the test material is of considerable importance.

When the substance under study can be shown to follow an analogous course of metabolism to that of components of known natural foods, proof of the safety of the product usually can be adduced with a smaller number of tests than when nothing is known about the nature of the material under test. For example, the proof that sorbic acid is metabolized qualitatively and quantitatively the same as the naturally occurring caproic acid is convincing evidence of its innocuousness.

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DO PRESENT GRADE STANDARDS FOR PROCESSED FOODS MEET THE NEEDS OF THE CONSUMER?

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In attempting to answer such a question concerning the adequacy of grade standards, consideration must be given to the use to be made of the product and the qualities which would prove desirable in each case, as well as individual and regional differences in food preferences. In many foods present Agricultural Marketing Service grades may not correctly reflect consumer ideas. Flavor, tenderness, and nutritive value combined with fair pricing are important factors which must be given considerable weight. For example, should ascorbic acid content of frozen concentrated or canned orange juice and of canned tomato juice be incorporated into grade standards? The public consuming such products is unaware of the great variation of vitamin C which can and does occur. On the other hand, the consumer may not be so particular about color, uniformity, wholeness, and defects as is believed. The need exists for constant and more specific meanings of grade designations.

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EDWIN BRET HART — HIS LIFE AND MEMORIES OF HIM

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THIRTY-TWO YEARS ASSOCIATION WITH E. B. HART

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CONTRIBUTIONS OF E. B. HART TO ANIMAL NUTRITION

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THE IMPACT OF E. B. HART'S CONTRIBUTIONS ON HUMAN NUTRITION

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Food and Drug Administration
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E. B. HART'S CONTRIBUTIONS TO FOOD TECHNOLOGY

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THE IMPORTANCE OF THE RELATIONSHIP BETWEEN FOOD AND PACKAGING TECHNOLOGY

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To set forth the justification for a packaging session at a meeting of the Institute of Food Technologists, the growth of packaging technology is outlined as evidenced by the new interest shown in the subject by educational institutions, the growth of technical societies devoted to packaging, and the interest of food management. It is also pointed out how the progress of food technology is closely related to the package and how certain phases of packaging are necessary to bring food research to a successful conclusion in the eyes of management and consumer. The varied demands placed on the packaging technologist by groups other than food research, such as sales, distribution, merchandising, and purchasing groups, are also presented.

A yardstick by which it can be determined whether or not food packaging research is going to be effective is given in an outline of some of the attributes a packaging technologist should possess if he is to be successful.

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CURRENT STATUS OF PLASTIC FILMS IN FOOD PACKAGING

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The food processors' viewpoint of plastic films for packaging is presented. The particular assets and liabilities of polyethylene, vinylidene chloride, vinyl, and Pliofilm are discussed. Free films and laminations will be considered, primarily from the point of view of presently available materials and as a quick look at potentials for the future.

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NEW DEVELOPMENTS IN PAPERBOARD CONTAINERS

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Recent advances in the construction of paperboard containers, which provide improved functional protection of various kinds such as resistance to transmission of grease and of water vapor, and recent developments in automatic packaging, which decrease operating costs, are reviewed.

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NEW DEVELOPMENTS IN METAL CANS

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New can constructions have been the subject of considerable recent developmental work. The major research endeavor, however, concerns reducing or eliminating the packaging industry's dependence on tin. Out of this work is expected to come the cans of the future. An extensive search has revealed no one material as universally applicable as tin plate. Sheet metals which may serve as alternates for certain applications are discussed. These may necessitate new can manufacturing procedures, particularly side seam closure techniques. Cans with cemented side seams and all-around lithography are already being manufactured for a number of products. Extending the use of cements and the welding of the side seams are under consideration.

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NEW DEVELOPMENTS IN GLASS CONTAINERS

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Changes in the distribution and retail merchandising of foods have stimulated the use of glass containers. This, coupled with the research activities of the glass and closure industries, has in turn resulted in marked improvements in glass containers and their closures over the past 10 years. These are reviewed in this report.

Practical things the packager should know about glass containers and closures are discussed. These include physical characteristics, dimensional tolerances, nomenclature, and specifications. Closures and their various methods of application are similarly covered.

The latest developments in the fields of glass handling, aseptic packing in glass, retort processing, inspection, shipping container research, improved car-loading practices, and shipping experience are also covered.

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NEW DEVELOPMENTS IN SHIPPING CONTAINERS FOR FOOD

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Recent, novel and useful developments in shipping containers for a variety of foods and food products are discussed. A number of container types, materials and components for general and specific applications are reviewed.

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THE DISCOLORATION OF PECTIN GELS

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The storage discoloration of fruit preserves and jellies involves, in addition to pigment degradation, a nonenzymatic darkening of the colorless constituents present, i.e., sugars, acids, and pectin. To determine the importance of this darkening in the overall discoloration of fruit preserves, model system studies were carried out using synthetic pectin gels. Significant darkening accompanied heating treatments comparable with those encountered in open kettle preserve making. Further darkening was incurred in the course of storage. The development of browning was paralleled by the formation of sugar degradation compounds such as 5-hydroxymethyl-2-furaldehyde. Factors promoting darkening include cooking and storage temperatures, high acidity, and the presence of fructose or of ascorbic acid. Gels containing glucose discolored least, as did gels held at a higher pH (ca. 3.5). The nature of the headspace gases in contact with the gels, during heating and storage, accounted for relatively slight differences in darkening rates.

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POLYPHOSPHATES IMPROVE CALCIUM-PECTINATE GELS

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Calcium pectinate gels formed in the presence of polyphosphates showed a marked improvement in gel strength and other properties. Under optimum conditions, the addition of 0.4% polyphosphates more than doubled the gel strength. This represents a 30 to 40% saving in the quantity of pectinate required to obtain a given gel strength.

Four types of polyphosphates were tested and all were effective in increasing the strength of calcium pectinate gels. Improvement of gel strength was observed in the pH range 3 to 7, with the maximum increase observed at pH 4.5.

Commercial and laboratory-prepared pectinates derived from apple and citrus pectins responded to the addition of polyphosphates. Pectic acid showed the greatest improvement in ease of gel formation and final gel strength.

Several possible explanations of the effect of polyphosphates on calcium-pectinate gels are discussed.

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THE CHROMATOGRAPHIC ESTIMATION OF ACETYL GROUPS IN PECTINS

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In studying the functions of naturally present or introduced acetyl groups in pectins, a dependable method was sought for the estimation of the acetic acid derived from these compounds upon hydrolysis. This study brought out the well recognized unreliability of the various methods described in the literature when applied to pectic substances.

In the proposed method the acetyl groups are liberated by hydrolysis with cold dilute alkali, and the acetic acid is determined by the now fashionable silica gel column chromatography. By avoiding the use of strong alkali and acid, and of heat, the formation of formic and acetic acids from galacturonic acid and polygalacturonic acids is prevented. Data are presented to demonstrate the usefulness of the method together with the results of determinations of some commercial beet, citrus, and apple pectins.

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THE PRECIPITATION OF PECTINIC ACIDS BY ALUMINUM SALTS

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The changes in state of several aluminum salts (aluminum chloride, aluminum sulfate and potassium alum) during neutralization with several alkalis ($NaOH$, Na_2CO_3, NH_4OH) were ob-

served, to determine the pH range in which colloidal suspensions were formed. The effect of pH on the yield and composition of pectinic acids precipitated by various aluminum salts brought to various pH values by different alkalis was then determined. The yield of aluminum pectinate, the ash content of the salt formed, and its uronide content were found to vary with pH and type and concentration of aluminum salt used to precipitate the pectinic acids present in an acid extract of orange peel. During precipitation a measurable increase in pH was observed; this was used as the basis of a new explanation of the formation of aluminum pectinates. Ion exchange rather than mutual colloidal precipitation apparently is involved.

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THE PECTOLYTIC ACTIVITY OF EXTRACTS OF TYPES OF ONIONS

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This study was undertaken to determine the relationship of the pectic enzymes to the specific resistance of onion types to mold infection.

Studies were made on 6 mold cultures grown on the extracts of bermuda, yellow and white onions. Spores of *Alternaria humicola, Fusarium oxysporum, Botrytis cinerea, Penicillium* sp., *Aspergillus niger* and *Mucor* sp. were inoculated into standard amounts of sterile onion extract. The polygalacturonase-like activity for each mold on each type onion extract was determined at intervals of 1.5, 2.5, 3.5, and 4.5 days.

The results of this portion of the experiment indicated that the cultures could be placed into 2 main groups with respect to their elaboration of polygalacturonase-like enzymes. The first group included *Alternaria humicola, Fusarium oxysporum* and *Botrytis cinerea* which produced the enzyme very slowly and showed little macroscopic evidence of growth, with the exception of *Botrytis cinerea* which eventually produced a maximum measurable tier of the enzyme with no macroscopic evidence of growth. The second group consisted of *Penicillium* sp., *Aspergillus niger*, and *Mucor* sp., which showed rapid enzyme elaboration along with rapid growth. *Penicillium* sp. showed slower mat formation than did the other 2 organisms in this group. In general, the polygalacturonase-like enzyme elaboration of each culture behaved quite similarly on the extracts of the 3 types of onions.

Further studies were made as to the pectinesterase titer of yellow and white onions. A relationship was found to exist between the pectinesterase titer of the types of onions and the susceptibility of these types to mold infection. Additional tests are being conducted to more definitely establish this relationship.

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GLYCOSIDIC HYDROLYSIS OF PECTIC MATERIALS BY TOMATO POLYGALACTURONASE

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The rate of hydrolysis of the polygalacturonide linkages in pectin and Wichman pectic acid at pH 4.5 by tomato polygalacturonase from Pearson and San Marzano varieties has been investigated. Polygalacturonase activity was determined by decrease in viscosity and increase in reducing value accompanying hydrolysis. The results indicate no significant difference in level of polygalacturinase activity between the two varieties. It was found that mono-, di-, and tri-galacturonic acids are the products of hydrolysis when 50% of the total polygalacturonide bonds are hydrolized. The activity of tomato polygalacturonase toward pure tetra- and tri-galacturonic acids will be discussed.

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CHARACTERIZATION OF PECTINESTERASE IN ORANGE CONCENTRATES AND RELATED MODEL SYSTEMS

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Although the most abundant constituents present in orange concentrates are sucrose, invert sugar and citric acid, no information is available concerning the effect of these constituents on the activity of orange pectinesterase naturally occurring in these products. This paper presents results of studies characterizing the properties of pectinesterase in orange juice at various levels of concentration, and in model systems of the major constituents found in orange juice. These constituents appear to have a marked effect on pectinesterase activity when present in amounts found in orange concentrates. Concentrations of sugar and citric acid in excess of those found in four-fold (42° Brix) orange concentrates are capable of delaying cloud loss, as well as inhibiting pectinesterase activity. However, it is not certain that the two effects are directly related.

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MODE OF ACTION OF FRUIT PECTOLYTIC ENZYMES AND OF THE FORMATION OF PECTIN IN FRUIT

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A study of the specificity of the enzyme pectinesterase, which appears to be universally present in fruits, revealed that its action was restricted to the polymethyl esters of polygalacturonic acid, since such esters as the triesters of trigalacturonic acid and the diesters of digalacturonic acid were not hydrolyzable by this enzyme.

Previous studies of the mode of action of polygalacturonase of fungal origin revealed that this enzyme acted on deesterified polygalacturonides in a somewhat random manner and eventually converted them to galacturonic acid. Tetra-, tri-, di-, and galacturonic acid have all been identified among the products of partial hydrolysis. This enzyme hydrolyzed the di- and trigalacturonic acid at a rate only 5% of that of polygalacturonic acids of higher degrees of polymerization. It has recently been found that the glycosidic enzyme of tomatoes and avocados acts in the same manner as that of mold origin. Paper chromatographic studies revealed the presence of tetra-, tri-, di-, and galacturonic acid when the enzyme from these two sources hydrolyzed polygalacturonic acids.

Unripe avocados and pears were found to have no measurable polygalacturonase activity. Upon ripening, however, considerable activity was observed. The pectic substances extracted and characterized from ripe and unripe fruits were found to reflect changes both in degree of esterification and in loss of molecular size, indicating that during ripening the pectin enzymes became active or were generated and attacked their substrates, the pectic substances. These changes in properties of pectic substances parallel the observed changes of softening of the texture in fruits as they ripen and suggest that pectic substances, pectic enzyme activity, and the texture of fruit are closely interrelated.

The incorporation of radioactive glucose into a ripe cane berry indicated that pectin was formed directly from the glucose. Glucose labelled in carbon one was converted to radioactive pectin in which the carbon one of the galacturonic acid was the most highly labelled.

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THE HYDROLYSIS OF PECTIC ACID AND SOME OLIGOURONIDES BY YEAST POLYGALACTURONASE (YPG)

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The yeast *Saccharomyces fragilis*, when grown in synthetic medium with glucose as carbon source, produces an exocellular polygalacturonase-like enzyme, which has been named yeast polygalacturonase (YPG). The yeast does not secrete pectin esterase into the culture liquid. Previous studies have also shown that when YPG is allowed to act on pectic acid at pH 5.0, the reaction shows a distinct break in reaction velocity at the point of 25% glycosidic hydrolysis, where a second slower linear rate begins. Finally the reaction slows down to an extremely low rate after about 50% of the glycosidic bonds of pectic acid are broken. At this point, the reaction products constitute a mixture of mono-, di- and trigalacturonic acids. Recent work, in which

tetragalacturonic acid was used as a substrate, has shown that the optium pH of the breakdown of this acid is 3.3—3.4, whereas the optimum pH with pectic acid is 4.4-4.5. Trigalacturonic acid is also hydrolyzed much faster at the lower pH. In the light of this last observation, we have restudied the breakdown of pectic acid at pH 3.4 and found that the final reaction products constitute a mixture of mono- and digalacturonic acids. At this point 70% of the glycosidic hydrolysis has occurred. YPG is apparently unable to attack the dimer. The trimer is broken into mono- and digalacturonic acids. The tetramer is first split into 3 + 1 fragments followed by a much slower breakdown of the trimer into 2 + 1 fragments. Pentagalacturonic acid can be split either into 4 + 1 or 2 + 3 fragments. Comparative rate studies with pectic acid and the oligouronides will be discussed. Trigalacturonic acid, but not di- or monogalacturonic acids, can cause inhibition in the breakdown of tetragalacturonic acid.

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INCIDENCE AND ENZYMATIC ACTIVITY OF MOLDS FOUND IN INDIANA TOMATOES

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A study was made of the influence of genera and species of molds isolated from different varieties of tomatoes grown in the tomato-producing sections of Indiana on the degradation of the whole fruit intended for processing. Field and factory examinations showed mold counts did not provide a reliable index for assessing the deterioration of tomato fruits in all instances. The relative amounts of pectolytic enzymes and cellulase produced by 172 isolates representing the principal molds encountered during the 1953 season were determined. The data are discussed as they concern the breakdown of the middle lamella and loss of quality in the tomatoes.

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INVESTIGATION OF METHODS FOR INCORPORATION OF NATURAL FRUIT FLAVORS INTO FRUIT POWDERS

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As a phase in a broad program for the preparation of full-flavored fruit juice powders, studies were undertaken to develop methods for returning the volatile fruit flavors separated from the fruit juice during dehydration. Two problems are involved: recovery and reduction of volatile flavors to a nonaqueous concentrate and sealing this concentrate in an edible solid carrier that prevents oxidation and volatilization. Recovery of flavors of Concord grape, apple, and strawberry was accomplished by flash vaporization of 10 to 35% of the water according to previously described procedures. Concentration of the flavor to about 500-fold was carried out by distillation in an Oldershaw type of fractionating column. A nonaqueous flavor concentration (approximately 20,000-fold) was prepared from this aqueous concentrate by liquid-liquid extraction with isopentane and subsequent removal of the isopentane by distillation. Since the amount of flavoring component is small (several grams per ton of fruit) an edible high-boiling extender, such as a vegetable oil, was added prior to removal of the isopentane. Organoleptic tests have shown that very little change in quality of flavor occurs during preparation of this product. With citrus fruits the recovery and concentration steps are unnecessary, since readily obtainable peel oils were found to be satisfactory flavoring agents. The preparation of "locked" flavors in solid carriers was accomplished by emulsifying the flavor oil in the molten carrier and allowing the mixture to cool to obtain a dispersion of oil globules within the resulting solid. One gram of solid product containing about 5% flavor oil provides flavor for about one quart of juice prepared from the fruit-juice powder. Supercooled dextrose and other sugars maintained in the amorphous state by addition of crystallization inhibitors were found to be satisfactory carriers. Studies with sorbitol showed that its usefulness as a carrier is limited to the metastable crystalline form.

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RATES OF NONENZYMATIC BROWNING OF WHITE POTATO

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To obtain information on the rate of nonenzymatic browning (or "heat damage") of white potato during dehydration, studies were conducted with blanched potato half-dice held at various constant moisture levels and constant temperatures covering the range encountered during dehydration. Nonenzymatic browning was measured by a *soluble color* procedure. The data show that browning increases in approximately linear manner with time (pseudo-zero order reaction), and that the browning rate is greatest at a moisture content of 15 to 20%. The rate increases rapidly with increasing temperature, about 3- to 6.5-fold per 10° C. (18° F.) rise between 40° C. (104° F.) and 100° C. (212° F.); the rate follows the Arrhenius relationship; i.e., plots of the logarithm of the rate vs. the reciprocal of the absolute temperature are straight lines. The apparent activation energies ranged from 25 to 37 kg.-cal./mole, increasing with decreasing moisture content below about 20% moisture. Vacuum packing reduced the rate of browning of the high-moisture samples to as little as one-fourth that in air, but had no apparent effect on drier materials (below about 15% moisture). Use of these data for estimating, as a first approximation, the expected extent of browning of white potato under various conditions of dehydration will be discussed.

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CALCIUM CHLORIDE AS A NON-ENZYMIC BROWNING RETARDANT FOR DEHYDRATED WHITE POTATOES

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An earlier report has shown that treatment of white potatoes with calcium chloride during dehydration processing makes possible the production of potato dice with improved dehydration and rehydration characteristics. The present report shows that the presence of calcium chloride in dehydrated potatoes also renders them less susceptible to non-enzymic browning during storage, and that this greater resistance to browning is related to the calcium content of the product. Sensory evaluations have shown that considerable amounts of calcium chloride may be added without sacrifice of acceptance.

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FACTORS AFFECTING THE TEXTURE OF REHYDRATED POTATO GRANULES

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Addition agents such as calcium chloride glycerol monolaurate were studied and found to be beneficial to texture of the reconstituted granules. Conditions of cooking, mashing, and mixing during manufacture of granules affect the amount of cell breakage and consequently the texture. Effects of rate of water absorption during reconstitution and amount of water absorbed were studied.

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A METHOD FOR THE COMPARISON OF CONSISTENCY IN POTATO GRANULE SAMPLES APPRAISED AT DIFFERENT TIMES

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A method is described by which samples of potato granules, appraised at different times, can be compared. In this method groups of four samples of reconstituted granules are ranked for rubberiness with two coded controls, and each unknown is placed in a category relative to the controls. The categories are based on an arbitrary interval around each control and are not affected by the number of judgments of their variability. Five categories are possible: A, less than first control; B, like first control; C, between first and second controls; D, like second control; and E, more than second control.

To determine the reproducibility of the method, a trained panel appraised selected samples several times in different groups to see if they would fall into the same category repeatedly. In twenty-eight reappraisals, eight samples shifted by one category. When controls were selected that were not very different in consistency, shifts in category were more frequent than when differences were larger.

Storage at 90° F and 100° F resulted in decreased rehydration (and decreased rubberiness). Data are also presented on reconstitution variables related to the appraisal of potato granules.

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A COMPARISON OF THROUGH AIR FLOW AND CROSS AIR FLOW METHODS FOR THE INITIAL DEHYDRATION OF SWEET CORN

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High, medium and low temperature schedules were used for through-flow dehydration. Simulated parallel and center exhaust cross air flow dehydration methods were also studied. Air velocity and tray load were investigated. Samples were prepared using various combinations of dehydration conditions and evaluated initially and after 1½, 3, 6 and 12 months of storage.

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PRODUCTION FEASIBILITY OF DEHYDRATED SWEET CORN

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A small pack of dehydrated sweet corn was prepared during the 1953 season. The production methods were based on results of research conducted by the Quartermaster Food and Container Institute, and research performed under contract with the Quartermaster Corps by the University of Illinois and Iowa State College. The processing schedule, production difficulties encountered and product characteristics are presented together with the future outlook for the product.

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PRODUCTION FEASIBILITY OF DEHYDRATED GREEN BEANS

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Research studies carried out under the auspices of the Quartermaster Food and Container Institute have shown that a dehydrated green bean product can be produced on a laboratory scale. The problems involved in large quantity production were investigated through a limited procurement of this item during the 1953 season. Processing steps are discussed and specific difficulties inherent in these steps are indicated, together with possible solutions.

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NEW BUSINESS OPPORTUNITIES IN THE GROCERY FIELD

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The oversimplified formula for finding new business opportunities might be found in the old phrase, "Find the need; then fill it." To conform to our stepped up standard of living, this formula should probably be expanded to read, "Create a desire; then satisfy it." The product satisfying a desire has much greater chance of continued success if it can be adapted to modern production methods, is in step with trends of the time, and is priced right.

Guide lines which can help direct our efforts in the fields of social, market, and technical research will be presented and discussed. These tools are used to assist us in the all important job of "picking a winner."

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MARKETING AND DISTRIBUTION OF FOODS

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Before a food product can be used, it must be made available to the consumer in her shopping place. Some of the problems encountered in making a food product available can be solved by finding answers to the following questions: *What does a company's sales department do to get distribution in stores? What do store managers consider important when asked to allocate space for a given product? What are the complexities of running a modern store? What techniques are important to get the shopper to buy given products? What does the shopper consider important when she buys?*

These are some of the questions which arise in the minds of nearly all food technologists; they will be answered in this paper on marketing and distribution.

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FOOD ADVERTISING

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Advertising employs many technologies.

Essentially advertising creates and maintains wants, and it must create them so economically that its cost is returned with a profit.

What are the most effective appeals? What illustrations or form is the best to use to capture attention? What media, under various circumstances, should be selected? These are questions at the core of advertising, whether it is called a technology or an art.

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EVALUATION OF MARKETING PROGRAMS

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"The best way to evaluate a marketing program is to wait until the program is over and say it was good or bad." In today's competitive market this type of evaluation cannot be tolerated.

We must know before spending money to promote a product what can be expected as a potential market.

There are yardsticks and guide lines available for use as the program progresses. The proper interpretation of these guide lines is essential to modern marketing.

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THE UNITED STATES FOOD AND DRUG LAW: ITS PROFOUND ECONOMIC AND SOCIAL AND LEGAL IMPORTANCE

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This paper will be a discussion of the important points of the Federal FDC Act from the standpoint of an attorney who has specialized for many years in such legislation, working in close cooperation with the Federal Food and Drug Administration and the food industry.

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PROBLEMS ENCOUNTERED IN THE DEVELOPMENT AND ADMINISTRATION OF A STATE FOOD AND DRUG REGULATORY PROGRAM

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This paper will review some of the problems which have arisen in relation to State regulatory legislation as represented by the State of California, which has an outstanding record for legislation and administration in this field.

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RECENT AMENDMENTS TO THE FEDERAL FOOD, DRUG, AND COSMETIC ACT

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There have been several proposed amendments to the Food, Drug, and Cosmetic Act. At least one of these, the Factory-Inspection Amendment, has been enacted. The effect of this amendment on the day-to-day work of Food and Drug inspectors will be discussed.

Other legislation is still pending. It cannot be predicted which of these amendments may be enacted or their final form when passed by Congress. Some are highly controversial. The background of the more important of these amendments and the results which they are expected to achieve will be discussed.

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THE FEDERAL LAW AND PROPOSED AMENDMENTS AS THEY AFFECT FOOD STANDARDS

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One of the most important provisions—and most far-reaching—of the Federal Food, Drug, and Cosmetic Act is Sec. 401 which authorizes the Secretary of Health, Education and Welfare to promulgate, with the effect of law, standards of identity for foods. Once a food is standardized, there is a "freezing" effect. No ingredient may be used in such food if not included in the standard. Many claim this discourages research into new and useful ingredients for standardized foods. However, the advantages of standards to consumer and the manufacturer must be weighed against possible disadvantages. Furthermore, standards can be amended. Finally, the Secretary can change the administrative attitude as to the makeup of standards which could go a long way towards eliminating the discouragement of research. Pending bills which will have the effect of facilitating the standards-making process will be discussed.

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PROTECTIVE PACKAGING OF FROZEN FOODS

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The frozen food industry from its inception has been handicapped in procuring efficacious, economical, protective packages, suitable for high speed operational handling. The conditions surrounding the packaging of frozen foods are unique in that not only the products, but also the handling and storage are departures from those of fresh, dried, heat-processed, or other perishable foods. The retention of quality in frozen foods is as dependent on packaging as on any other factor since protection is required against (a) moisture losses, which result in loss in weight and fresh appearance, causing dullness of the product; (b) exposure to air, which results in oxidation, rancidity, or change in color and flavor; (c) loss of volatile flavors, resulting in blandness; (d) loss of nutritional value, especially vitamin C; (e) mechanical injury, crushing or tearing, resulting in unsalability of the product.

Although a "standard frozen food container" for the several hundred products is impractical, research in commercial and governmental laboratories is steadily improving packages that are (a) distinctive of the method of preservation; (b) stable at temperatures from 100° to −20° F.; (c) adaptable for home, institutional and commercial use; (d) suitable for production line fabrication, filling and closing, and easy removal of contents without special equipment; (e) nontoxic, odorless, and practically hermetically sealed; (f) capable of withstanding handling in storage and transportation; and (g) economical in price.

Materials being evaluated include tin plate, glass, aluminum, aluminum foil, cellophane, polyethylene, polyvinal chloride, polyvinylidene chloride, rubber hydrochloride, rubber latex, trifluorochloroethylene, glassine, chipboard, kraft sheets and board, thermoplastic resins, microcrystalline wax, and combinations of one or more of these.

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EFFECT OF SUCROSE AND ASCORBIC ACID ON QUALITY RETENTION IN FRESH AND FROZEN STRAWBERRY PUREE

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Experiments designed to show the effect of sucrose and ascorbic acid on the quality of fresh and frozen strawberry puree are described. Deteriorative changes in the quality of fresh puree occurred within 2 to 3 hours at room temperature, and sucrose in a (4 + 1) ratio neither prevented nor minimized the development of off-flavors. The addition of sucrose or ascorbic acid prior to freezing offered no apparent advantage with respect to quality retention during freezing, storage, and defrosting. This was true of the purees packed in a commercial plant as well as those which were prepared in the laboratory.

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COLOR OF CITRUS PRODUCTS

I. Color Differences of Citrus Juices and Concentrates using the Hunter Color Difference Meter

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Color is an important characteristic of citrus juices and frozen concentrates. The Hunter color difference meter has been used to measure color differences in various citrus products. Using orange, grapefruit, and tangerine juices and concentrates, data indicated that this instrument is capable of measuring differences in color of citrus products caused by such factors as fruit variety, pulp content, and storage.

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MANDATORY STANDARDS PROGRAM ON QUALITY FACTORS FOR FROZEN ASPARAGUS AND PEAS—AN INDUSTRY APPROACH

I. Purpose and Organization of Program

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In preparation for anticipated promulgation of mandatory standards on frozen asparagus and peas by the Food and Drug Administration, the Research and Standards Committee of the National Association of Frozen Food Packers has instituted a comprehensive program of research that was carried out at Oregon State College and the University of Maryland over the past several years. Legal counsel, technical personnel, and consultants made plans for determining the industry's preliminary position and for effecting the necessary research to check the preliminary position and to develop a final industry position that will provide for fair and equitable standards.

II. Selection of Official Analytical Procedures

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Uniform and objective methods of evaluating the quality of frozen asparagus and peas were developed and adopted by mutual consent of representatives of the Food and Drug Administration and the National Association of Frozen Food Packers. These include possible procedures for measuring off flavor, fibrousness and maturity. Procedures for cooking and organoleptic evaluation of off-flavor, fibrousness and maturity by expert taste panels are also presented.

III. Evaluation of Results

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Data obtained by use of objective and organoleptic methods were analyzed statistically. The best method for each quality factor is indicated along with the standard-substandard quality limit as calculated from regression equations.

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EFFECT OF FREEZING CONDITIONS ON APPEARANCE OF FROZEN POULTRY

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Requirements for freezing conditions to insure optimum appearance in frozen poultry, and particularly turkeys, have become more critical during the past several years due to several changes in production and processing practices. The principal change has been the adoption of higher scalding temperatures (subscald at about 140° F.) in preference to semiscald temperatures in the range between 125° F. and 130°F. This change was made to obtain a pinfeather-free bird at reduced processing costs. However, the higher temperature scald results in the removal of the cuticle or outer skin layer, leaving a pink, shiny surface that is more susceptible to drying and darkening during freezing. Precautions are necessary to prevent dehydration in freezing, as well as in all other phases of processing and marketing. Moisture-proof packaging is essential. Rapid rates of freezing are especially important to prevent dehydration in the unfrozen state and to increase opacity of the skin layer by formation of small sized ice crystals. Changes in appearance of frozen subscald birds will be discussed as functions of temperature, air velocity, and method of loading of blast freezers. The effect of finish (amount of fat in skin) on frozen appearance and need for rapid freezing rates will be covered in relation to problems with mature turkeys and more importantly with the immature, thin skinned, fryer-roaster turkeys. All changes in appearance will be discussed in terms of the basic properties of the layers of the skin and of the flesh surface underneath.

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CONTROL OF MOLD IN STRAWBERRIES BY TREATMENT IN THE FIELD, IN TRANSIT, AND IN THE PROCESSING PLANT

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Loss of strawberries to freezers resulting from rot and mold growth in the field, in transit, and during holding is in excess of $1,000,000 each year. Both growers and packers have been striving to curtail losses and to eliminate this serious problem.

Control naturally begins in the field and a variety of fungicides and mold inhibitors have been tested. To date, two materials, Captan and Ferbam, show promise of reducing rot at least one-third. The growth and spread of mold and rot is also influenced by the condition of the containers used for picking, transportation, and holding the berries. Data are presented to show the advantages of waxing the wooden hallocks commonly used for harvesting strawberries in the Northwest, both from the standpoint of economy through re-use, and through better control of the spread of mold and rot. Other types of containers available for strawberry harvest are also discussed. Wood preservatives are considered briefly.

Data are presented on trials using wetting agents of the alkyl aryl sulfonate type and the polyoxyethylene ester type to reduce mold counts by means of more efficient washing.

Control of rot and mold in strawberries and the use of improved and more economical harvesting containers become very important in the face of rising costs for producing frozen strawberries.

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RECENT PROGRESS IN THE DEHYDROFREEZING OF FRUITS AND VEGETABLES

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Dehydrofreezing, a process which combines the advantages of dehydration and freezing and at the same time eliminates many of the disadvantages of each, is being used by several companies to provide various types of products needed in their operations.

Commercial packs of dehydrofrozen apples and pimientos of substantial size have been prepared. The apples are primarily for institutional or bakery use and the pimientos for remanufacture. At the present time there is little indication of commercial interest in dehydrofrozen fruits or vegetables for retail marketing.

Dehydrofrozen apples have been found to be adaptable to procedures used in both large and small bakeries and are liked because of their ease of handling, low sulfur dioxide content, and excellent overall quality. Dehydrofrozen pimientos have been found to offer advantages in handling in addition to having better color and flavor than other types of processed pimientos. Flavor, color, and particularly the firm texture of dehydrofrozen apricots in preserves have been reported to be advantages in this product.

Substantial progress has been made toward the development of a continuous dryer suitable for the partial dehydration of apples and perhaps other commodities for dehydrofreezing, thereby making possible reduction in dehydration costs and increasing uniformity of drying.

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THE USE OF IONIZING RADIATIONS IN THE ERADICATION OF INSECTS IN PACKAGED MILITARY RATIONS

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The use of ionizing radiations for the control of insect infestation in certain military ration components has been investigated. Dose requirements of high-energy cathode rays, X-rays, and gamma rays for destroying all metamorphic forms of several species of insects have been determined.

Panel tests indicated that there were no detectable organoleptic changes in cereal and fruit ration bars that had been irradiated at dose levels found necessary for insect destruction.

Effects of these radiations on the functional properties of packaging materials were studied. No detectable changes in these properties were observed at the dose levels required for insect destruction.

Specifications have been suggested for a process of complete insect destruction in cereal-bar and fruit-bar ration components by the use of high-energy cathode rays.

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THEORETICAL CONSIDERATIONS IN FOOD PROCESSING BY GAMMA RADIATION

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The methods developed to date for determining gamma radiation requirements for food processing do not consider certain aspects relating to the geometry of the absorber and the radiation resistance of the contaminant. A method for determining the isotopic requirements for gamma radiation processing of foods in conventional packers' containers takes these factors into account.

The basic Vitro equations for calculating gamma radiation intensity are coordinated with recent concepts of thermal process evaluation. The total lethality and effectiveness of the process are calculated by integrating the lethal effects throughout the container.

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STUDIES IN THE COLD STERILIZATION OF LIQUID FOODS USING HIGH ENERGY RESONANCE RADIATION

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An investigation has been made of the bactericidal effectiveness of the two resonance lines of mercury in the irradiation of liquid food products. Special equipment has been developed to study bactericidal activity and chemical changes which occur in food products exposed to the high-energy 1849 Å line of mercury. Precautions were taken to assure penetration of the radiation in the exposed samples.

Since milk is extremely sensitive to slight changes in chemical composition, this system has been chosen for detailed study. Data will be presented on the changes in bacterial counts and on flavor alterations, under aerobic and anaerobic conditions, for varying exposure times and intensities for both of the aforementioned frequencies.

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FOOD PHYSICS

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Recent advances in food technology emphasize the growing importance of physics and electronics to the food industry. Continued progress in high-speed processing, non-destructive analysis, and automatic process control requires teamwork between the food technologist, who usually knows very little about physics, and the physicist, who probably knows even less about food technology. It appears doubtful that there will ever be a large number of technical men with sufficient training in both fields to be called "food physicists"; hence, the food technologist must have sufficient background to know when and how physics may be useful in solving a particular problem.

This paper discusses some of the problems peculiar to research in food physics, and suggests ways in which the food technologist can make maximum use of the tools and techniques of physics that are available to him. Several examples of successful applications in the food industry are described.

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METHOD OF DETERMINATION OF GAS IN VACUUM-PACKED FOOD PRODUCTS

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The effects of air on the qualities of various food products during storage are discussed. The ways by which air may be introduced into the food product during its packing are pointed out. Literature is reviewed on the existing methods of determination of air in foods. A new method is described for the determination of gas in packed food products, based on the principle of air displacement by a suitable liquid. It is particularly adaptable to emulsion-type food products, such as mayonnaise, where the air may be emulsified and occluded. The advantages over previously published methods and the limitations of the method are pointed out.

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THE QUANTITATIVE DETERMINATION OF COLORING MATERIALS IN BUTTER AND MARGARINE

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Although carotene is the principal natural pigment in butter, it is quite common practice to supplement the natural coloring with annatto extract, the "certified" coal tar colors FD & C 3 and 4, or carotene. Margarine is coloring principally with coal tar dyes or carotene.

Because of the current interest in different food colors, it is of interest to have suitable methods for the determination of the type and quantity of coloring materials in any sample of butter and margarine. A procedure for accomplishing this will be described. Without necessity of saponification, carotene is separated from the carrier oil by means of a simple chromatographic separation. Annatto extract is separated from the oil by means of a mild alkaline extraction while the two "certified" coal tar dyes are removed by means of acidic reagents. After these pigments have been separated from each other they can be determined spectro-photometrically.

This new procedure has been tested on samples of butter and margarines which contained known quantities of the various coloring agents. Then the method was used to examine coloring in many samples of butter and margarine purchased on the open market. While this technique is specifically designed for butter or margarine, it can be applied to many other food products where yellow oil colors occur.

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RESISTANCE OF CLOSTRIDIUM PARABOTULINUM TO SORBIC ACID

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Studies made in connection with investigations on the microbiology of dehydrated vegetables confirmed the fact that sorbic acid is an aid in the selective enrichment and isolation of anaerobic, spore-forming bacteria of the genus *Clostridium* as well as the lactic acid bacteria as suggested earlier (J. Bact., *63*, 487-494, 1952).

However, because of recent interest in sorbic acid as a fungistatic agent it was desirable to study its effect on the clostridia in more detail. Some of these latter investigations showed that *C. parabotulinum* (18 cultures of type A and 16 cultures of type B) and *C. botulinum* (1 culture each of types D and E) all grew in the presence of 0.12 percent sorbic acid in liver infusion without added phosphate. The cultures of *C. parabotulinum* all grew well and sporulated in the presence of 3.0 percent sorbic acid at pH 6.7. Spores of all of the *C. parabotulinum* isolates germinated in the presence of 2.5 percent sorbic acid in liver infusion also at pH 6.7. Growth of the different isolates in the acid range (pH 4.5 to 6.0) was not appreciably affected by the presence of 0.12 percent sorbic acid in liver fusion. Filtrates toxic for mice were obtained when cultures of *C. parabotulinum*, types A and B were grown in liver infusion broth with either 0.12 or 1.0 percent sorbic acid. Conventional use of botulinum antitoxin and heated filtrate controls indicated that botulinum toxin was produced. Sorbic acid in concentrations of 0.12 or 1.0 percent in a suitable peptone basal medium apparently is utilized by all cultures of *C. parabotulinum*.

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AN INVESTIGATION OF THE USE OF PLASTIC FILM PACKAGES FOR HEAT PROCESSED FOODS

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The purpose of this work was to determine the feasibility of using plastic film packages for heat-processed food. The first phase of the study concerned the investigation of plastic films to determine which might offer the required properties. Three films were found which exhibited superior characteristics regarding heat stability and moisture vapor, oxygen, and organic vapor transmission and other factors. Two of these films proved satisfactory for heat processing of tomato juice, apple sauce, beef stew, and club steaks. Although the results obtained from this work demonstrated the possibility of using plastic film material for this purpose, many additional problems remain to be solved before practical use can be made of this work.

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STARCHY THICKENING AGENTS FOR CANNED FOOD PRODUCTS

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Investigation of autoclaved pastes made from wheat flour, waxy rice flour, cornstarch, and waxy cornstarch, and various mixtures of these, by means which permit the substantially independent measure of apparent viscosity and of gel strength, indicates the possibility of controlling these properties with considerable degree of independence in foods in which thickening agents are used.

Such control may be achieved by use of mixtures of waxy-cereal thickening agents, which contribute to apparent viscosity but not to gelation, and normal thickening agents, which contribute to both.

The results show that during storage of pastes and of a thickened carrot purée, the apparent viscosity does not change while gelation may increase steadily over a considerable period of time.

The gelation of these pastes is shown to have an exponential relation to the amylose concentration.

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PROGRESS OF RESEARCH IN THE UNITED KINGDOM ON FRUIT AND VEGETABLE DEHYDRATION

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Government and government sponsored research in the United Kingdom was abandoned in 1945 and not resumed until 1948. A coordinated research programme between the Department of Scientific and Industrial Research and the Ministry of Food has been developed during the past few years, including both basic and applied approaches. The Ministry of Food has built and equipped an Experimental Factory in Aberdeen mainly devoted to applied research in dehydration as a part of this programme.

The overall objective in food dehydration is the production of compact stable foods which on reconstitution closely resemble the fresh material. This objective is being approached by basic research on (1) oxidative rancidity and the break-down of carotenoids; (2) the internal chemical reactions of non-enzymatic browning, and (3) the factors influencing texture deterioration on processing and storage. No appreciable work has yet been done on oxidative rancidity in fruits and vegetables, but in connection with off-flavors resulting from the break-down of carotenoids advances have been made in the extraction and identification of carotenoids from tomatoes and swedes including the discovery of 6 lycopene isomers not previously reported. Work on the browning reactions has resulted in progress in the isolation and identification of primary reactants in fruit and vegetable tissues. Studies are being made of the chemical nature of the cell walls in relation to reconstitution and texture.

The storage life at high temperatures of vegetables dried by conventional hot air methods has been extended by reducing the water content by varying the strip size, the drying conditions, and the use of bin drying. It has been found that at low water contents the proportion of sulphur dioxide in the free state increases and remains high.

The main advance in processing in the United Kingdom has been in the development of vacuum contact plate drying. This method is versatile in that it is applicable to fruit, vegetables, meat and fish. It permits the drying of larger units of material, e.g. whole tomatoes, and the initial quality of the products has invariably been more satisfactory than those dried by conventional means.

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PROBLEMS IN PRODUCTION OF TOMATO JUICE POWDER

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Production of a tomato juice powder by vacuum drying that will readily reconstitute with cold water to a full bodied juice has been found to be feasible. Two general methods have been tried for making this product: (1) Single-strength juice is centrifuged to separate pulp and serum fractions. The latter is concentrated to 60-70° Brix and the two fractions vacuum dried separately on trays. The dried products are blended after grinding. (2) High-density tomato paste is aerated and vacuum dried under specified conditions of temperature and pressure so as to produce a sponge-like, friable product that mills readily.

The major problem has been to obtain a powder in which the pulp fraction will readily disperse to give the proper consistency when reconstituted with cold water to single-strength juice. Procedures have been found which yield products that meet this requirement. Certain properties of the tomato juice or paste used to make the powder have been found to greatly influence the consistency of the reconstituted juice. Other variables that have been investigated include: degree of concentration of the paste used as feed; gas dispersion in the feed paste; various additives to the feed paste; drier pressure; drier shelf temperatures and product temperatures; drying times; tray loading; package density of the finished product; and reconstitution of the powder to single strength juice. Need for incorporating volatile flavors is discussed.

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STORAGE STABILITY OF TOMATO JUICE POWDER

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Effects of temperature, packaging atmosphere, and moisture content on the storage stability of tomato juice powder were investigated. Samples packaged in tin in air, tin in nitrogen, and tin under vacuum with and without an in-package desiccant were stored at 70° and 100° F. Comparisons with control material (nitrogen-packed samples stored at −30° F.) were made by a trained taste panel after 6 weeks, 3 and 6 months of storage. Chemical analyses were also made at each interval. Results indicated that samples stored at 70° F. retained good flavor and color. On the other hand, materials stored at 100° without in-package desiccant (initial moisture content 2.6-3.0%) showed a marked loss in flavor and increased darkening as judged by the panel and by measurement of soluble color. Ascorbic acid retention after 6 months of storage was high in all samples stored at 70° and in the vacuum-packed sample containing in-package desiccant stored at 100° F. Samples stored at 100° F. without desiccant lost approximately two-thirds of their initial ascorbic acid in 6 months. Oxygen was absorbed in samples packed at both 70° and 100° F. but the rate of absorption was much lower at the lower temperature. Decomposition of samples stored at 100° F. was indicated by an increase in moisture content of the powder and by an accumulation of carbon dioxide in the packaging atmosphere. These changes were noted in both nitrogen- and air-packed samples. Tomato powder packed under vacuum or in nitrogen and stored at 70° F. with moisture content in the range of 2.6-3.0% showed relatively high stability. However, it was necessary to lower and maintain the moisture content below 1% for stability at 100° F.

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STUDIES ON RECONSTITUTION OF CERTAIN DEHYDRATED FRUIT AND VEGETABLES

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These studies were conducted to determine the effect of certain variables in reconstitution procedures on the quality of dehydrated diced potatoes, flaked onions, French green beans, sweet corn and apple slices. The reconstituted products have been judged chiefly on the basis of the grams water absorbed per 100g. of original dehydrated product (percent water absorption). This has been determined at intervals during soaking and during complete reconstitution, and variables have included the proportion of water to product and the initial temperature of the water used. Experimental work has been chiefly with 4-serving portions but for each product some experiments have been repeated with large (50 or 100-serving) portions, using several of the more important variables. In general, varying the proportion of water to product (within the reasonable limits which were used) had little effect on the percent water absorbed either during soaking or during complete reconstitution. Increase in initial temperatures of water increased the rate of water absorption during soaking and during complete reconstitution. However the effect of initial temperature of water on percent water absorbed when product was reconstituted to doneness varied with the product.

The effect of varying degrees of water hardness contributed by different salts ($CaCl_2$, $CaSO_4$ $MgCl_2$ $MgSO_4$ and $Ca(HCO_3)_2$) was also investigated, and was compared with the effect of reconstituting in distilled water. For each product, the rate of water absorption was noted, using a standard method of reconstitution. There seemed to be a tendency for calcium salts to decrease water absorption, though not consistently. The effect of magnesium salts was similar to that of calcium salts, but less pronounced. Occasional increase in water absorption was found from both salts, but particularly with magnesium salts. In addition, the effect of varying concentrations of each salt on the texture of each reconstituted product was noted, rating texture by taste panels. The texture of diced potatoes reconstituted in such waters was also measured objectively on a Carver Press adapted for use in this study. The firming effect in general in these experiments tended to be more pronounced with calcium than with magnesium salts, though this was not consistent. The effect of $Ca(HCO_3)_2$ was quite inconsistent.

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CONTINUOUS VACUUM DEHYDRATION OF ORANGE JUICE

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In a study of the feasibility of the laboratory-developed procedure for the preparation of a stable, high quality, dehydrated orange juice powder for volume production, the material has been manufactured, for trials by the Office of The Quartermaster General, in a continuous vacuum dehydrator. Description of raw materials, manufacturing processes, packaging, equipment requirements nd other operating considerations are reported. The outstanding characteristics of the product hold promise of commercial and military use.

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DESIGN AND CONSTRUCTION OF A CONTINUOUS COLUMNAR DRYER

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The design of a new type of continuous dryer for free-flowing particulate materials is shown. This unit utilizes the through-air circulation principle of a bin dryer, but the material descends vertically as columns under the action of gravity. Air direction is reversed at approximate mid-point of the dryer in order to promote moisture uniformity. The unit is enclosed for conserving heat by air recirculation. All moving mechanical parts are outside the dryer enclosure in the interest of ease of maintenance and sanitation.

In addition to granular chemicals, plastics and catalyst beads, this dryer is adaptable to the drying of foods such as beans, feed pellets, corn, sorghum, rice, cereal grains and processed cereals (breakfast foods), shaped foods such as alimentary paste products (macaroni, noodles etc.), coffee, and cocoa beans.

Along with the description of the dryer, the experimental method for its development is presented.

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NEW THROUGH-FLOW ROTARY DRYER FOR THE PARTIAL DRYING OF APPLE SLICES

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A new type through-flow rotary drier was developed and used successfully in a semi-commercial operation to partially dry apple slices for dehydrofreezing. The drier consists essentially of a rotating wire cloth lined drum with air delivered up through the bed of material in the drier via 4 separate but adjacent air-duct compartments located longitudinally along one side of the drier. Four blowers and 4 steam-air heating coils supply drying air at the proper controlled temperature. The separate blowers and heating coils give flexibility for study of design features.

In cooperation with a commercial processing plant at Watsonville, California, 60,000 pounds of fresh, sulfited Newtown Pippin slices were dried to 50% weight reduction under both high and low humidity drying conditions, depending upon the amount of SO_2 desired in the final product. Higher humidities favored low sulfite concentration in the final product; lower humidities markedly increased drier capacity.

Partially dried slices produced by the drier were of very good quality, natural creamy white in color, with clean sharp-cut edges and surfaces free from mechanical abrasion.

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SWEET CORN DEHYDRATION: THE FALLING-RATE PHASE

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The drying characteristics of partially dehydrated sweet corn in the falling-rate phase ($T = 0.8$ to $T = 0.05$) were investigated in a pilot plant through-flow drier. Variables studied included air temperature (110° F. to 180° F.), air velocity (50 to 250 feet per minute), air humidity (5% to 25% R.H.) and bad depth (2 inches to 8 inches). Rates of drying were followed by means of periodic moisture determinations. Final product quality was evaluated by means of density, dehydration ratio, soluble color and organoleptic determinations. Principal variables in the dehydration process shown to have an effect were found to be air temperature and bad depth. Soluble color value was shown to be a good indication of heat damage and proved to be a useful means of evaluating drying conditions. From data obtained, it may be concluded that drying air temperature largely controls the rate of drying in the falling-rate phase of sweet corn dehydration, and that selection of the drying air temperature in this phase of drying must be based primarily upon dried product quality with rate of drying assuming a secondary role.

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PRODUCING FLORIDA CITRUS FOR FROZEN CONCENTRATE

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Production of Florida citrus fruit for the past 2 years has exceeded 100 million boxes and represents more than two-thirds of the total United States citrus production. More than half of this fruit was processed. An adjunct of the increased production and consumption of Florida citrus frozen concentrate has been the development of cultural programs designed to produce fruit of high juice quality. An increasing number of processors are willing to pay for fruit according to its soluble solids and juice content because high solids fruit results in increased plant capacity, reduced production costs and increased quality of the finished product. The grower, consequently, must adopt practices known to produce high internal quality fruit and discard those which adversely affect it.

Vigorously growing stocks, such as rough lemon, produce more fruit but with a lower soluble solids content than slower growing stocks such as sour orange. Deficiencies of nutrient elements such as magnesium, zinc, manganese, iron and copper reduce the soluble solids, acid and vitamin C content of the fruit, whereas excessive applications of potash also reduce the soluble solids content. The latter may result directly or indirectly through the production of larger sized fruit.

Excessive or poorly timed irrigation and improper timing of soil sprays result in reducing the soluble solids content of the fruit and dollar returns to the grower.

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CHARACTERISTICS ON CONCENTRATES MADE FROM DIFFERENT VARIETIES OF CITRUS FRUITS

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The quality of frozen citrus concentrates, like other food products, depends largely upon the quality of the fruit from which they are made. In Florida, many different varieties of citrus are used for the manufacture of frozen concentrates. Such products often have different characteristics depending upon the variety of fruit utilized. Characteristics of concentrates made from Hamlin, Pineapple, Valencia and Temple oranges, Duncan and Marsh grapefruit, and Dancy tangerines will be discussed, including the relationship between fruit variety and occurrence of gelation and clarification, pectin-esterase activity and its inactivation, pectin content, color, and flavor.

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PLANT SANITATION AND PLANT MICROBIOLOGICAL CONTROL METHODS

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The fruit used in production is the primary source of microorganisms in the product. The numbers of organisms in the product are also dependent to a great extent on plant layout and juice handling methods. Growth of organisms initially present in the juice can be minimized by proper control of time and temperature. Control of the time factor involves complex adjustments of production methods to compensate for stagnant

deposits and similar factors. The efficiency of corrective production measures can be checked by several microbiological methods such as plate counts, direct microscopic counts and diacetyl analysis. The safety of a process can be estimated by new methods of interpretation of microbiological data involving such factors as pH, growth rate and population levels.

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THE SLIDE PLATE METHOD OF ESTIMATING THE NUMBER OF VIABLE MICROORGANISMS IN ORANGE JUICE

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The slide-plate method—a modification of Frost's little plate procedure—utilizes ordinary bacteriological equipment to obtain bacterial and yeast counts in orange juice after an incubation period of 7 hours. From the results of tests conducted with several hundred samples of single strength juice, the counts estimated by the slide-plate method compared favorably with the counts obtained using the standard plate count procedure.

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SOURCES AND DETECTION OF VOGES-PROSKAUER REACTANTS IN CALIFORNIA VALENCIA ORANGE JUICE

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Chemical and bacteriological methods were applied to the examination of California Valencia orange juice to determine the source and significance of neutral volatile substances capable of producing a positive Voges-Proskauer reaction. The sensitivity of the existing V-P method was increased to allow detection at a level of 0.25 p.p.m. Examination of defective fruit and juice in process demonstrated a correlation between chemical and bacteriological data. However, a naturally occurring substance was found in orange juice which fractionally distills to produce a positive V-P test. Several genera of bacteria and yeast isolated during this study are capable of producing Voges-Proskauer reactants in orange juice and from its major carbohydrate constituents tested individually in suitable media.

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THE ROLE OF THE EVAPORATOR IN THE PRODUCTION OF FROZEN CONCENTRATES

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Evaporator units for the production of frozen concentrate have progressed significantly since the early units of 1945. The philosophy as to the function the evaporator should fulfill has also changed significantly. It is pointed out that the evaporator must now be considered in relation to the complete process. The tremendous strides made in control of other processing invariables has had a bearing on evaporator design.

Important details in evaporator design such as heat transfer rates, vapor velocities, control of sanitation problems, removal of non-condensibles, and the general problem of transit times in relation to storage volumes are covered.

The economies to be gained or lost through interstage cooling or reheating are discussed. An example of the design of a multistage double effect unit fitted to a particular plant and a particular process is given.

The problem of evaporator design is discussed in relation to the pressure exerted by the customer in asking for the most economical unit for the production of a particular kind of product. Improved techniques have removed the stimulus for certain evaporator features. At the present time, unless the processor asks for different features, evaporator improvement will be principally directed at economies in manufacture and operation.

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EFFECT OF CONCENTRATION ON QUALITY OF FROZEN ORANGE JUICE WITH PARTICULAR REFERENCE TO 58.5° AND 42° BRIX PRODUCTS

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Effects of concentration on the stability of orange juice determined by retention of cloud and flavor, microbial activity and other factors resulting from processing methods and handling and storage conditions were investigated. Commercial procedures were utilized to prepare the test concentrates. Both unheated and heat stabilized juices were studied. The stability of the cloud of orange juice ranging from 10 to 70° Brix was compared in the temperature range of 0 to 80° F. by recording optical density. The stability of concentrate increases with concentrations above 42° Brix.

Growth behavior studies were made on selected strains of yeasts, lactobacilli and leuconostoc in orange concentrate ranging from 12 to 70° Brix at temperatures of 0 to 75° F. In general, an increase in concentration resulted in a decrease in the initial rate of growth of the microorganisms studied.

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DIFFERENTIAL METHOD OF CLOUD DETERMINATION IN FROZEN ORANGE CONCENTRATES

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Differential cloud values are determined in a given sample of frozen orange concentrate immediately after thawing and again after holding at 40° F. for over twenty-four hours. This differential cloud determination has been applied over the past two and a half years to five lots of commercial frozen orange concentrate stored under constant and fluctuating temperature conditions. The results indicate that low cloud values observed immediately after thawing reflect previous exposure to elevated temperatures. Low cloud values observed after holding the sample for twenty-four hours at 40° F. reflect "sensitization" of concentrate to cloud loss which follows prolonged storage even at 0° F. It has been found that the differential cloud determination yields data from which information relative to the age and previous temperature history of frozen orange concentrate may be deduced, and the future cloud stability of the product prognosticated.

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NEWER CONCEPTS OF OPTIMUM NUTRITION

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The life span approach to defining optimum nutrition is beginning to be understood, even by the man in the street. Of course, the medical profession is still perplexed by many of the research ramifications in this kind of thinking, but carefully controlled experiments made with animals that complete their life span within a few years, give us a remarkable insight for preliminary interpretation of the human situation. Hence, we have moved rapidly from the elementary concepts of appetite, growth, and protection against deficiency diseases into the new area where we appraise the quality of the diet in terms of its known composition and in terms of our best estimates of the intake levels that will sustain the body in its optimum functions through a life span.

Each year, for the last few decades, new essential nutrients have been discovered—whether vitamins, minerals or amino acids. The functions and interrelationships of these nutrients, however, and their long-time appraisal in terms of such complex functions as glandular balance and hormone control will require intensive study in animals and man for a long time to come. It is in this new area, however, that we now find our best guidance toward optimum nutrition—not only for the medical profession but for the man in the street as well. This new trend focuses increased attention upon the work of the biochemist and the food technologist, to give our population maximum assurance that our health is being protected. For the food technologist, this also means an increased appreciation of the

value of food as our most important protective factor for the *preservation* of health.

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MINERAL NUTRITION—THE ROLE OF TRACE ELEMENTS

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The term "trace element" has been applied in the biological sense to those elements which, in extremely small amounts, play some part in the nutrition and metabolism of living organisms. The term came into existence about the time that vitamins, which are the organic counterparts of these nutrients, were recognized. As our knowledge of the nutritional role of each group has increased the interrelationships of these nutrients become more and more evident; for example, the relation of cobalt to vitamin B_{12}.

There are 20 or more mineral elements which occur commonly in foods in trace amounts or in amounts less than .005%. Of these, 10 must be given consideration in living matter; namely, boron, cobalt, copper, fluorine, iodine, iron, manganese, molybdenum, silicon and zinc. Other elements may be naturally present in foods or gain access from industrial processes.

Since some of the trace elements are active in extremely small quantities it is very difficult to produce uncomplicated deficiencies in animals through the use of highly purified diets. Further information is being obtained from studies on the identification of new compounds, especially enzymes which contain mineral elements. Special emphasis will be given to these studies and their relation to food production and processing.

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THE TEAM—THE FOOD ENGINEER AND THE FOOD TECHNOLOGIST

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Our food manufacturing industry faces a most serious and challenging technical situation. It is critically short of the only kind of technical teamwork that will permit it to modernize and expand as dictated by economic pressures and business opportunities. We estimate, and we believe conservatively, that no fewer than 10,000 more *food engineer-food technologist* teams are needed in the food and associated industries.

There are 10,000 food factories (of a total of 36,000) with 20 to 99 employees. Each of these needs this team of technical know-how. Another 3,000 food factories have 100 or more employees. On the average, each of these can use two of the teams. Then at least 1,000 companies producing equipment and "technical" materials and supplies for the industry each need at least one *food engineer-food technologist* team. This adds up to 17,000. There now are about 7,000 engineers in the industry. So, 10,000 more are needed.

By way of comparison, the chemical processing industry has at least 35,000 chemical engineers and 10,225 plants with more than 20 employees.

A survey of men directing the operations in food plants reveals that 70% find food engineering involved in their work. Among research directors, food technologists, and chemists, the figure is 74%. Considering the number of corporate officials, managers or superintendents, scientists, engineers, and others in key positions in the industry, this adds up to a lot of engineering.

A great upsurge in unit operation progress and general plant modernization got under way in the industry following World War II, and is continuing at an accelerating pace. The industry literally has entered a new era in its development.

And engineering is involved every step of the way because the changes and the improvements involve machines and thermodynamics and factory layout. So, too, is food technology involved all the way. Not only are product research and development, quality control, and sanitation essential, but every operation in manufacturing, processing, and materials handling must be right from the viewpoint of food science.

The food industry is spending 800 million to a billion dollars annually for new plants and equipment. And the pace setters report intentions to increase the capital investment per worker significantly in the next 5 to 10 years.

On top of this, the industry came into 1954 with the greatest demand ever for its products, particularly the newer convenience items. It will take modernization and the *food-engineering-technology* team to capitalize upon this opportunity. And only through engineering can the results of technologic food research and product development be put into commercial production at a profit.

All the while competition gets tougher in the food industry as the pace-setters modernize for higher efficiency. To stay in the swim, all food companies must have the *food engineer-food technologist* team pulling them ahead.

Although up slightly in the last half of 1953, the average food manufacturer's profit was then only 2.4 cents on the sales dollar. That is by no means enough. And the only way to raise it is to engineer more efficiency into operations, put profitable new products on the market, and improve existing products in relation to competing items. Again, it is the *engineer-technologist* team that can do it; and only this team, led by enlightened management, will take the industry forward to full achievement of its opportunity.

It is high time for all food companies to take their heads out of the sands of times gone by and face up to the demands and the challenge of the present and the future.

From here in, the only food manufacturers who will survive are those who hitch their wagons to the *food engineer-technologist* team.

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ENGINEERING ASPECTS OF FOOD PRODUCTION UNIT PROCESSES

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A broad understanding of the engineering aspects of food production units, by food processors, is essential to the proper choice and application of equipment. The increasing complexity and specialization of modern food production equipment make development more expensive and require coordinated effort of different specialized skills, scientists, and food technologists. Development cost is a little understood price element of equipment, incorporating the services of market analysts, statisticians, and economists, as well as of engineers. Efficient application of equipment to a unit process necessitates close cooperation between manufacturer and buyer and a mutual understanding of equipment performance, specifications, and process requirements. Qualitative performance, productivity, efficiency, labor savings, investment, and energy requirements are primary considerations. Economical layout of space requirement, interrelation between successive unit processes, maintenance schedules, and obsolescence are less tangible but no less important factors in consideration of equipment application to unit processes.

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THE INTERRELATIONSHIP OF SCIENCE, TECHNOLOGY, AND FOOD ENGINEERING TO THE TECHNICAL SUCCESS OF FOOD PRODUCTION

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In the final analysis *technical success* in food production is achieved through adequate control of the materials and procedures of production. The term "control" has been used (*Food Technol., 7, 10 (1953)*) to indicate the ability to determine the physical and chemical nature of the finished product at will. If we extend this concept of control to cover the ability to operate effectively and modify, as desired, each step of the manufacturing procedure it will include all of the factors essential to the technical success of production.

If for the purpose of this discussion *science* is defined as comprehensive knowledge of the basic properties of matter and energy, if *technology* is defined as the application of that knowledge to products and processes, and if *food engineering* is defined as the art of integrating both science and technology in practical food production, the conception that all three contribute to "the ability to control" at virtually every phase or step of food production follows immediately. An attempt will be made to analyze these interrelationships in some detail, and to show by example how the analysis applies in practice.

The extent to which science, technology and food engineering are utilized for control will ultimately determine the degree of technical success achieved. This requires adequate appreciation by management of the interrelationship of science, technology and food engineering, men trained in all three and the physical facilities to effectuate their coordination.

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THE FOOD ENGINEER AND FOOD INDUSTRY PROFITS

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Engineering has been a principal factor in making the United States, uniquely in history, an area where a great population finds food surplus rather than food scarcity a major problem. Food variety, quality, and nutritional values have varied over the years since mass food production and mass food processing were introduced by engineers, but all aspects are now being improved. Much of the food industry has narrow profit margins, which means that sound food engineering is essential to survival and that the intelligent managerial use of food engineering is essential to reasonable profits and normal progress.

Food engineers and engineering methods are permeating management increasingly in the food industry. Modern management policy in the use of engineering gives many companies in the industry a stronger competitive position, aids the industry, and results in better and cheaper foods for the consumer. The rate at which management and engineering increase mutual respect, understanding, and participation in improved managerial practice depends largely on the initiative of the food engineers themselves. Engineering schools and company managements are doing their part in preparing food engineers and giving them opportunity. Increasingly, food engineers are being made or are making themselves aware of managerial problems, objectives, and policies. Food engineering research and design practice are improving, and engineering methods are being applied to an expanding spiral of management problems—inventories, distribution, and even promotion and sales.

Profits in the food industry will depend largely on the success of these programs.

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ANALYTICAL PROBLEMS ENCOUNTERED IN ATTEMPTS TO CHARACTERIZE AND LOCALIZE METABOLIZED INSECTICIDE RESIDUES IN FOOD PRODUCTS

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Some success has been achieved in demonstrating losses in identity to the analytical method of field-applied insecticides which have penetrated into plant parts. For example, parathion does not volatilize appreciably from treated citrus fruits, yet 21 days after application nearly 2/3 of the originally contained parathion has been degraded or otherwise metabolized to the point of no response to the chemical test for the nitrophenyl moiety as well as loss of energy absorption at 274 mμ. Similar "fates" for other penetrating insecticides are readily demonstrated.

There is reason to postulate that such metabolizing processes may produce flavor changes in the substrate via at least 2 paths. Even the qualitative demonstration that fragments or metabolic derivatives of penetrated insecticides produce such flavor changes is methodologically difficult. The analytical problems associated with such attempts will be discussed in detail.

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EVALUATION OF PESTICIDES FOR ENTOMOLOGICAL EFFECTIVENESS AND INFLUENCE ON CROP FLAVOR

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For the past 2 or 3 seasons the Entomology and Food Technology Departments of the University of California have cooperated in a study of the entomological efficiency and the effect on flavor of the crop of a number of the newer organic pesticides. Investigation has centered on soil treatments for root crops and miticide sprays for deciduous fruits. The project involved growing, treating, and processing the crops under controlled conditions; running chemical and biological assays for residues and for pesticidal effectiveness; organoleptic examination of the fruits and vegetables by trained consumer panels; and evaluation of the data.

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THE FOOD FLAVOR PROBLEM IN PESTICIDE RESEARCH

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It is now necessary to determine that a new pesticide does not detrimentally affect the flavor of food products before it can be registered for commercial use. This report includes a discussion of flavor studies conducted routinely since 1952 in the pesticide screening program by the Department of Entomology at the University of California Citrus Experiment Station at Riverside. Also included is a discussion of flavor studies on citrus products conducted cooperatively with the U. S. Department of Agriculture, Bureau of Agriculture and Industrial Chemistry at Pasadena, California, and the Sunkist Growers at Ontario, California.

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DO PESTICIDES CAUSE OFF-FLAVORS IN CITRUS PRODUCTS?

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Past experience has indicated that lindane and benzene hexachloride produce off-flavors in certain food products, while other pesticides such as toxaphene, Systox, aldrin, dieldrin, and heptachlor are under suspicion as causing similar flavor differences. As a result of these observations off-flavor development in a number of food products treated with pesticides is being investigated by federal, state, and industry laboratories.

The Pasadena Laboratory is cooperating with the Entomology Department of the University of California Citrus Experiment Station at Riverside in studying off-flavor development in citrus juices prepared from pesticide-treated fruits. Selection of the pesticides to be tested, their application to citrus trees, evaluation of the pesticides for insect control, and the estimation of pesticide residues in the fruit are performed by the Citrus Experiment Station. After the sprayed fruits, with unsprayed controls, have been examined and analyzed they are delivered to the Pasadena Laboratory where they are washed, juiced, and processed under semi-commercial conditions. Half of the juice is processed as a frozen 4-to-1 concentrate, while the other half is pasteurized and canned as single-strength juice. The frozen samples are stored at 0° F., and the pasteurized samples at 70° F., and both lots are taste-tested immediately after processing and after 6 and 12 months' storage. The triangular taste-test is used on all samples, in which individual tasters are given 2 samples which have received the same treatment and one sample receiving a different treatment. Panel members are requested to direct their attention to the detection of flavor differences between samples, and no effort is made to correlate results with consumer preference. The individual reactions are tabulated and analyzed statistically. Similar taste tests on duplicate samples are made by a panel at the Citrus Experiment Station, and a third industry panel is available to check samples suspected by either group as having an off-flavor.

Storage tests have been completed on orange juices prepared from fruits sprayed with sulphenone, EPN, and Systox, and no off-flavors were detected by either panel. Orange juices prepared from fruit sprayed with amiticide (D228) are now under test and no off-flavor was detected in any of the freshly processed samples.

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THE USE OF THE TRIANGULAR AND MULTIPLE COMPARISON TASTE PANEL METHODS FOR DETECTING POSSIBLE OFF-FLAVORS IN VEGETABLES TREATED WITH INSECTICIDES

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Canned and/or frozen samples of 9 vegetable products treated with different insecticides before harvest were submitted to taste panels in accordance with the triangular and multiple comparison systems. The results indicated that the 2 methods were of approximately equal effectiveness when the test material was uniform, such as a homogenized liquid.

As the product became more variable, and as the unit size increased, the multiple comparison method gained in efficiency,

until for such products as potatoes, it was 4 to 6 times as efficient as the triangular taste method. The multiple comparison method also provides a ready means of ranking the treatments, and removing causes of variability other than the insecticidal treatments.

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STUDIES LEADING TO THE DEVELOPMENT OF A "STANDARDIZED PROCEDURE" FOR MAKING FLAVOR EVALUATIONS OF CANNED FOODS TREATED WITH CHEMICAL PESTICIDES

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The authors have pooled their experience and have developed a tentative standardized procedure based upon the triangular method for making flavor discrimination tests in processed foods taken from plots treated with chemical pesticides. The California Experiment Station has prepared a special canned pack of pears taken from plots treated by the entomologists of the Station, and these samples were distributed to 10 laboratories in an effort to evaluate the standardized procedure and also compare it with other procedures for making flavor evaluations. These results have been compiled and will be presented.

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THE SURFACE DARKENING OF SLICED BEETS

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Surface darkening of Detroit Dark Red beets, *Beta vulgaris*, occurs in certain processing operations on sliced, cut and quartered beets. This blackening effect was reproduced on a laboratory scale and color photographs were made of various degrees of darkening. A beet center temperature of 165° F. (74° C.) during scalding prevented blackening. A procedure was developed employing the Hunter Color Difference Meter for measuring the color of beet slices by reflectance. Employment of this procedure, as well as a boiling water treatment of raw slices, allowed reflectance measurements to be made on the rate of the development of the black pigment. The prevention of blackening on heat treated slices and the general inhibitory effect of chemical agents on the rate of darkening was indicative of a polyphenoloxidase reaction.

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FACTORS ASSOCIATED WITH POTATO TEXTURE

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Studies were made on 10 varieties of potatoes, which were rated organoleptically as to their relative sogginess or mealiness after boiling. Specific gravity values were determined for the raw potatoes. Both raw and cooked tubers were analyzed for various factors of their starch content and of their pectic fractions. Mechanical measurements and histological sections were made with raw and cooked potatoes. Coefficients of regression were calculated between the organoleptic scores and the different analytical factors.

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FACTORS AFFECTING THE QUALITY OF PRE-PEELED POTATOES

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The introduction of pre-peeled potatoes into hotel, restaurant, and institutional channels has enjoyed considerable success, even though this product has not yet been marketed to any degree on the consumer retail level. Recent reports have estimated that upwards of 2 million bushels of potatoes are now being pre-peeled annually.

Inasmuch as freshly peeled potatoes are susceptible to both enzymatic and microbiological deterioration, means of preventing their discoloration in addition to refrigeration are necessary to prepare an acceptable product with an adequate shelf life.

Results of trials with various reducing agents, antimicrobial agents and combinations thereof, indicated treatments with solutions containing sulfur dioxide to be the most effective of those investigated. The relationship of the keeping of pre-peeled potatoes to their residual sulfur dioxide content as influenced by length of dipping time, concentration of the sulfur dioxide solution, and form of the potatoes (whole or slices for french fries) are presented.

Results are also reported on the effects of various cooking procedures on the residual sulfur dioxide content of pre-peeled whole and french fries as determined chemically and organoleptically.

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EFFECT OF TEMPERATURE AND OXYGEN SUPPLY ON THE PRODUCTION OF ACETALDEHYDE AND ALCOHOL BY FROZEN GREEN PEAS

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Raw peas and peas blanched in water at 60°, 82°, and 100° C. for 2 minutes and stored at −6.7°, −17.8°, and −29° C. in air or oxygen were analyzed periodically for their aldehyde and alcohol content. Alcohol dehydrogenase activity was also investigated.

There is a difference in the aldehyde and alcohol content of different lots of fresh peas. Within each lot, this initial content is appreciably affected by blanching, since heating at the higher temperatures caused a definite decrease in the amounts of the substances.

Increase in aldehyde and alcohol content was noted only in raw peas and in peas blanched at 60° C. when these samples were stored at −6.7° C. No increase took place at lower storage temperatures or with higher blanching temperatures. Presence of oxygen at −6.7° C. storage caused a definite increase in aldehyde production in raw peas and in those blanched at 60° C. over that produced in air, but did not have any effect on all the other samples. Oxygen did not affect alcohol production in any of the samples.

Alcohol dehydrogenase was found to be active only in raw peas and in those blanched at 60° C. for 2 minutes. This would explain the ability of such peas to produce alcohol when stored at −6.7° C. No direct relationship appeared to exist between aldehyde and alcohol production, and off-flavour development.

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FILM DEPOSITION OF TOMATO JUICE ON HEAT EXCHANGER COILS

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An experiment is described which shows the methods employed to prevent "burn on" or film deposition of tomato juice on the coils of an atmospheric cooker during evaporation. The addition of pectic enzymes to tomato juice was investigated and the results showed that polygalacturonase prevented film deposition. High pressure steam injection prior to evaporation of the tomato juice also inhibited the "burn on". Various sequestering agents were tested and some prevented film deposition to a limited degree. High overall heat transfer coefficients are also discussed.

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PROTECTING TOMATO JUICE AGAINST FLAT SOUR SPOILAGE

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This investigation was designed to study the effect of subtilin in conjunction with mild heat treatments on 11 strains of flat

sour spoilage bacteria in tomato juice. A wide variation in susceptibility of *B. thermoacidurans* strains was observed. It appears that in a given population there are resistant spores able to survive for a longer period of time than would be indicated by the large initial decrease in the number of surviving spores.

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CONSISTENCY OF PASTE AND PUREE FROM PEARSON AND SAN MARZANO TOMATOES

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Pearson and San Marzano tomatoes were grown and then processed into pastes and purees by hot break and activated cold break processes. The consistency of these samples at different soluble solids content was evaluated by Stormer viscosimeter, Bostwick consistometer, plate-spreading method, serum viscosity, and rate of filtration of the diluted serum. These data were then correlated with uronide and solids contents of the sample.

Results indicate that San Marzano and mixtures of San Marzano and Pearson tomatoes produce purees and pastes of better consistency than do Pearsons alone. Different harvests of San Marzano gave different consistencies at comparable solids levels, presumably due to varying pectin content. Pearson gave paste of commercially-acceptable consistency as long as there was efficient rapid heat inactivation of the pectic enzymes. The degree of degradation of pectic materials in tomatoes during evaporation in steam-jacketed kettles was demonstrated by the gradual decrease in total alcohol-insoluble uronide content.

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DETERMINATION OF COLOR IN SHELLED WALNUTS

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As part of an investigation on the preservation of shelled English (Persian) walnuts it appeared desirable to study the effects of heat, light, moisture, and oxygen on the darkening of the skin. However, objective measurement of the color of the walnut skin by direct colorimetric or photometric procedures is complicated by the irregular particle size and topography of the walnut kernel.

A satisfactory procedure has been developed for the estimation of walnut color based upon extraction with hot aqueous methanol and photometric estimation of the transmission of the solution at 400 mμ. The color, expressed as 0 to 100 color units, was obtained by interpolation from a standard curve prepared by plotting the logs of the transmissions obtained from dilutions of a weighed quantity of dried walnut skin extract.

Color determinations on various commercial grades of shelled walnuts indicated wide variations in color of different lots of the same grade of nuts. One half of a kernel of a dark walnut was sufficient to significantly lower the color value of 25g. sample of light grade walnuts.

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MEASUREMENT OF COLOR OF GROUND CAPSICUM SPICES

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Although the important relationship between color and quality in capsicum spices has been realized for many years, there are relatively few published data concerning reliable methods for measuring the color of capsicum spices. Consequently, a program has been initiated to investigate the various aspects of this problem. The development of a rapid objective method for measuring the color of prepared capsicum extracts has already been described. In the present investigation, the problem of preparing these extracts is considered.

Numerous methods of preparation are currently employed. One of the most common is an overnight extraction at room temperature with ethanol. This method has been found to be inadequate because it does not always give complete extraction and because the degree of extraction varies, depending on certain characteristics of the sample.

Raising the temperature to 70° C. results in complete removal of the pigments in 3 hours or less. Isopropanol can be used in place of ethanol, provided that certain differences in extraction properties and in the effect on the absorbancy index of the pigments extracted are taken into account.

An unusual change in the color of capsicum extracts has been observed when these extracts are exposed to radiant energy. The influence of this effect upon analytical results and procedures for controlling it will be discussed.

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STERILIZATION OF CUCUMBERS FOR STUDIES ON MICROBIAL SOFTENING

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Final proof of the etiological relationship of bacteria or other microorganisms of the softening of cucumbers must involve pure culture studies with sterile cucumbers whose original firmness has not been significantly altered. Because the usual methods of sterilization by autoclaving or intermittent steaming caused severe softening, lower temperatures were used. It was found that intermittent heating at 71.1° C. (160° F.) for 30 minutes on 3 or more successive days did not markedly reduce the original firmness of the cucumbers. However, at the higher pH values (5.5 to 6.5) in particular, sterilization was not always obtained. Therefore, a more reliable method for sterilization was sought. A number of exploratory experiments with various chemical agents and antibiotics indicated that the use of penicillin in combination with mild heat offered the most promising method at the present for sterilization of brined cucumbers. The method will be described in detail. Other promising methods will also be discussed.

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ALGEBRAIC AND GRAPHIC SOLUTIONS OF MIXING PROBLEMS INVOLVING ADJUSTMENT OF TOTAL SOLIDS AND RATIO OF SOLIDS TO CITRIC ACID IN FRUIT JUICES

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Blending frozen orange concentrate often involves the simultaneous adjustment of Brix and ratio by the addition of sugar with the required cutback juice. Since sugar and juice each affect both Brix and ratio, the mathematics is complex and has led to confusion and lost time. In the present algebraic treatment, the well-known formulas for the amount of sugar required to raise the Brix or ratio are used to calculate also the amount of sugar which would have to be removed (if possible) to lower the Brix or ratio to the desired value. The blending of juices (with or without the addition of sugar) then becomes a simple matter of balancing sugar deficiencies against sugar excesses. Adequate tables of these sugar requirements for juice and concentrates are presented for any desired Brix from 40 to 47.5° and for a ratio of 13. Two simple nomographs give the sugar requirements for any commonly desired ratio, and a double nomograph shows in 40 seconds the amount of cutback juice required with simultaneous addition of sugar to obtain a ratio of 13 with any desired Brix from 42 to 46. Finally, a completely general graphic method is given by which the proportions of any 3 juices or other suitable materials may be calculated in a few minutes. These methods, tables, and nomographs have been used in actual practice, effecting a 66% reduction in calculating time and providing a simple, uniform approach to the correction of off-batches. The technique is easily learned by persons of limited mathematical training.

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FROZEN GRAPEFRUIT, TANGERINE, AND LIMEADE CONCENTRATES

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Frozen, concentrated orange juice has achieved public acceptance and is enjoying great and continuing popularity. Other citrus juice concentrates, notably grapefruit, tangerine, and lime, can be prepared with only slight modifications of methods used for concentrated orange juice. Concentrated grapefruit juice showed a marked tendency to clarify and form gels, but responds to preliminary heat treatment for inactivation of the responsible enzyme, pectinesterase. Grapefruit concentrate of a pleasing pink color can be made from colored varieties by using cutback juice rich in comminuted naturally colored pulp.

Frozen tangerine concentrates show little tendency to clarify or gel, but the small, fragile fruit handles with some difficulty in regular orange juice extracting equipment.

Frozen lime juice products differ from the above concentrates in that they must be diluted to less than single strength for use. Prepared limeade contains the equivalent of about one part fresh lime juice to 6 parts of water. The frozen, sweetened limeade product already popular is composed of single strength juice sweetened to about 45° Brix, and limeade is prepared from it by diluting to approximately 4.5 volumes. Products have been prepared from concentrated lime juice which produce limeades of excellent quality. The high concentration of flavor required is supplied by carefully prepared lime puree. A sweetened concentrate is made into limeade by dilution with water to 8 volumes, and an unsweetened concentrate is made into 35 times its volume of limeade by adding sugar and water.

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CONCENTRATE FOR LEMONADE

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The designation "concentrate for lemonade" and such synonymous terms as "lemonade concentrate" and "concentrated lemonade," immediately bring to mind the quick frozen concentrated lemonade product whose production and consumption has skyrocketed so phenomenally since its advent in 1949. Whereas this paper deals primarily with the frozen type product, historical aspects and development of current standards require reference to the precursor, hot-packed concentrate for lemonade. Processing procedures, quality control, containers, factors affecting quality and storage life, industry standards and the microbiological aspects peculiar to these products are briefly discussed.

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FROZEN CONCENTRATED PINEAPPLE JUICE

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Commercial production of frozen concentrated pineapple juice follows an appreciably different pattern than that which is common for concentrated orange juice. These differences arise, since pineapple juice flavor is more heat stable, recovery of volatile flavor constituents is much more important, availability of juice is governed by cannery operations primarily concerned with the preparation of canned pineapple items, and concentrate freezing must be integrated with concurrent production of frozen pineapple chunks.

A description of the materials, equipment and operations involved in the production of frozen concentrated pineapple juice is given and covers the following points: source materials and equipment used in preparation of pineapple juice; evaporator and its operation; volatile flavor recovery; blending; canning; freezing; storage; shipping and quality control.

The development of off flavor during storage of frozen concentrated pineapple juice has been an appreciable problem and present knowledge concerning causes and control are discussed.

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UNIT SERVINGS OF CONCENTRATES IN FLEXIBLE FILMS

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Unit servings of citrus concentrates in flexible film have required a cooperative research program between the processors, packaging machine manufacturers, and the flexible film suppliers. Problems encountered in the development of automatic packaging machines and necessary flexible film suppliers for the satisfactory commercial application of this new field of merchandising are discussed. The packaging machines were required to give accurate fills and positive heat seals, and to be completely waterproofed and constructed of non-corrosive materials. Films were required to be flexible at low temperatures, have low water, oxygen, and organic vapor transmission rates, and have good printing characteristics. Successful commercial applications of this type of packaging are found in frozen orange and lemonade concentrates.

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PACKAGING OF FROZEN CITRUS CONCENTRATES

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Packages for frozen citrus concentrates have been developed and modified to solve problems which appeared only upon large scale distribution in retail channels. Tinplates, organic coatings, and methods of closure are evaluated in relation to product flavor and color retention.

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THE TRANSPORTATION OF FROZEN CITRUS CONCENTRATE

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Further studies on the truck transportation of frozen citrus concentrate have confirmed the original findings of undesirably high temperatures in bottom positions in the load caused by inadequate air circulation. To provide more favorable temperatures, disposable paper pallets 33" x 40" providing a 3-inch air space underneath the load were tested. These pallets held up satisfactorily under heavy loads and produced improved temperatures in the bottom of the load. Temperatures of + 4° to + 6° F. were found at unloading compared with 10° to 15° F. in similar trucks without these racks. Special return air ducts to improve air circulation around the load in trucks equipped with Thermo King units produced destination temperatures with a maximum of 3.0° F. as compared with a maximum of 14.0° F. in a trailer without this duct. Another mechanical unit, Transicold, in a test from Florida to California starting with a temperature of about −4° to −8° F. arrived with a maximum temperature of + 1° F. This trailer had adequate floor racks but not enough wall clearance and temperatures rose in side wall positions as much as 2° to 8° F. in transit. Dry ice units maintained acceptable temperatures of 4° to 6° F. in transit with a dry ice consumption averaging about 24 lbs. per hour. Dry ice on top of the load failed to give low enough temperatures. Another dry ice unit using a secondary refrigerant circulated through finned coils carried a load with a 3° to 5° F. rise in transit and a 2° F. maximum at unloading. The use of mechanically refrigerated rail cars is increasing with approximately 400 now in service and 300 more building or in order. Tests in all types of refrigerated transportation equipment for frozen citrus concentrate are being continued.

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USE OF CONSUMER AND TRADE SAMPLES IN PROJECTING CITRUS MARKETING DATA

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Data on consumption of citrus concentrates are useful to the industry in the purchase of the fruit, estimating price levels, and projecting demand and estimating inventory carryover. Long range forecasts on consumption are useful to help determine the rate of growth and use, trends in use rate and the effect of frozen concentrates on other citrus products. Consumer and marketing analyses also aid in promoting more effectively the movement of concentrates.

The consumer panel system is discussed with relation to the method used and the system of projection. The limitations of the system are also discussed as well as the mathematics involved. Examples of application of the data to the United States and to various regions are given. Future plans are described.

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CITRUS BY-PRODUCTS AND DERIVATIVES

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By-products and derivatives of citrus are now generally considered all those products made from one or more parts of the fruit exclusive of potable juices in all forms and juice containing beverages. Such by-products are of particular importance to the cooperative obliged to handle not only juice fruit, used for quality juice products, but also the frost damaged and lower grades for whatever values possible. Citrus by-products and derivatives fall within the groups—essential oils, pectic substances, flavanoids, molasses, dried meal, citrates, and specialties.

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NEWER CONCEPTS OF THE ROLE OF FATS AND THE ESSENTIAL FATTY ACIDS IN THE DIET

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The importance of fat in the diet will be discussed largely in relation to the function of the essential fatty acids. The importance of these compounds will be reviewed not only from the classical standpoint of their requirement for growth, but also from the viewpoint of their effectiveness in protection of rats from radiation injury, of their requirement for pregnancy and lactation, and of their importance in cholesterol metabolism.

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ROLE OF ANTIBIOTICS IN ANIMAL AND HUMAN NUTRITION

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Addition of certain antibiotics to the diet at low levels increases the rate of growth of young animals and the efficiency with which they utilize food. This effect of antibiotics is not obtained in environments from which bacteria are absent, such as in the chick embryo or in "germ-free" chicks, and the effect may be reduced when the animals are kept under highly sanitary conditions. Evidently certain widely-distributed types of antibiotic-sensitive intestinal microorganisms interfere with the utilization of food. The "wide spectrum" antibiotics produce the most consistent effects in the growth of animals over a range of species. The "dietary" effects reported for antibiotics include improvements in the utilization of food, sparing effects on the requirement for proteins and for certain minerals and vitamins, and anti-anemic effects under conditions where a response is obtained to folic acid. The antibiotic growth effect may be obtained when the diet is supplemented with more than sufficient amounts of the known vitamins. The tissues of antibiotic-fed animals are of normal composition.

The practice of feeding certain antibiotics to farm animals is wide-spread. No untoward effects on public health have resulted; for example, detectable amounts of Aureomycin are not found in meat even when the animals are fed antibiotics at levels far higher than usual; furthermore, many antibiotics are destroyed by cooking. The daily administration of small amounts of an antibiotic for prolonged periods to children has not been found to have untoward effects. Beneficial results have been reported when such a regime was used with premature infants. Resistant strains of pathogenic bacteria have not been reported to have made their appearance in animals as a result of feeding antibiotics. Reproduction in animals does not appear to be affected by feeding the antibiotics which are used in feeds.

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RECENT ADVANCES CONTRIBUTING TO THE STABILITY OF FOODS

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In its broadest sense, stability in foods refers to an ability to withstand changes in various perceptible and physiological properties including odor, flavor, appearance, texture, and nutritive value. Deteriorative changes may occur in carbohydrates, fats, proteins, and various minor constituents. Important types of deteriorative changes are brought about by microorganisms, enzymes, reactions with oxygen, reactions between food components, or physico-chemical phenomena.

Because of the breadth of the subject, attention will be given principally to recent developments in only a few major areas. These will include such subjects as fat rancidity, browning, microbial, and enzymic spoilage. Results of recent researches concerned with dehydration, freezing, and preservation of fresh meats and other foods will be mentioned.

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ENGINEERING ASPECTS OF FOOD PREPARATION IN THE CANNING INDUSTRY

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Food preparation in canning includes operations performed at the cannery prior to filling containers. Engineering research and development have made tremendous progress toward reducing hand labor in these operations. Without these developments increased cost of hand labor would have restricted many staple canned foods to limited luxury markets. Irrespective of cost, only a small fraction of current production in existing canneries would be physically possible without this mechanization.

Despite this progress, canning labor costs remain high and 30 to 70% is preparation. Complete mechanization covers almost all operations in which bulk handling is possible. Hand labor is largely confined to those operations in which units of product must be individually handled, either for their orientation in a subsequent mechanized operation or for sorting, trimming, etc. based on visual inspection.

Mechanization of operations now requiring visual inspection depends upon application of industrial electronics. Possibility of electronic sorting replacing visual inspection has been demonstrated. Electronic components of such machines function at virtually unlimited speed; therefore, capacity limits will be mechanical. Electronically recorded information may ultimately be used to activate automatic trimming devices.

Further automation in food preparation will require many automatic control devices. These are already available because of their development for the chemical industry. Future automatic food preparation machines, however, will be highly specialized and not obtainable as by-products of development in other industries. Therefore, automation of food preparation remains an urgent challenge to the food industry's own engineers, regardless of method by which preservation of the product is finally accomplished.

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EVAPORATION IN THE PRODUCTION OF MAJOR FOOD PRODUCTS

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This paper discusses the effect of evaporator design for food processing on such important factors as: (1) flavor; (2) nutrition, and (3) health of the ultimate consumer. Examples of a number of different evaporator types employed in several major fields of the food industry are also presented.

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ENGINEERING ASPECTS OF FOOD PACKAGING

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Scientific principles and discoveries are seldom commercially applicable until they have been "engineered" either as to production or utilization. Practice and theory often have a disconcerting way of parting company in industrial applications, or a new package may cost too much in man-hours, materials, or power consumed to be economic unless the application has received adequate engineering study and development. For all good engineering ends up with a dollar sign whether it be the engineering of a process and its equipment, or of the packaging by which the food is protected.

Translation of purely laboratory findings into industrial questions must take into account more than the principle to be applied. Process-time factors, material handling factors, labor-

and machine-time factors, inspection, and quality must be under satisfactory control in packaging the food as well as in processing the food, or the effort may be an economic, and even a technologic, failure.

In the packaging functions, three distinct types of engineering problems are involved: (a) the unit package (the package that is in contact with the product); (b) all the many steps involved in placing the product in the package, such as: filling, closing or sealing, perhaps also thermal processing of the filled package, labeling or wrapping, and inserting the filled package into the shipping container and sealing it; (c) the shipping container itself. Of the three, (b) is the location of most important items of controllable costs for studies have shown that an average of 59.4% of all direct labor-hours are packaging labor hours. Measured by people on the pay roll in the plant, packaging is our principal business. Industries other than the food processing industries show still higher figures, the grand average being 87.3%.

Many sound developments in food technology cannot be economically applied until the engineering of the packaging operations has been sufficiently developed to permit the packaged food to be sold at a competitive price.

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INSTRUMENTATION IN THE MODERN FOOD PLANT

I. Application of Measurement Principles in Instrumentation

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Primary elements of measurement for temperature pressure, level, flow and other process variables, means and methods of using these primary elements in control forms to operating in process through valves, dampers, or other control forms will be discussed. Special refreence will be made to the sanitary consideration for the application of industrial controls to food processing operations.

II. Types of Instruments and Their Application

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Various types of instruments, what is available, self-contained or self-operating units such as valves, dampers, switches, instruments of a more sophisticated nature and indicating process variables or a combination of any of the factors of indicating, recording and controlling, will be discussed. The means, methods, and availability of instruments for these purposes, as applied specifically to food processing operations, will be presented.

III. What's Ahead for Instrumentation in Food Industries

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Some recent developments in instrumentation involving particularly the control of process variables in continuous processes, an exposition of the newer trends in instrumentation with a glimpse of the possibilities for computers and servo-mechanisms to replace the aesthetic method, i.e., control by means of taste, feel, smell, or sight, will be presented. This will be integrated with the theme that the time for planning controls is when a process is engineered so that full advantage of the position of automatic control may be realized in conjunction with plant and equipment layouts and design.

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STUDIES ON THE MICROCOCCI OF MARKET FISH

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A selective enrichment medium for *micrococci* that contained propionic acid and salt was effective in isolating strains from fresh and frozen market fish. The sample when blended in this medium and incubated for 3 days at 37° C. permitted these organisms to over-grow associated types. The incidence of micrococci in 176 samples of fresh and frozen fish was 11.3 and 16.1%, respectively. Tests to suggest the possible enterotoxogenicity of such isolates indicated that pigment or hemotoxin production were variabile characteristics among such strains. Lactose and manitol fermentation, as well as coagulase production, were consistently positive. The latter test was observed to be affected by the freezing of the cells, the temperature at which they were stored and whether or not intact cells were present. After storage at — 9° C. quantitative coagulase titers were lower than for controls. The significance of these observations with regard to bacteriological methods for the study of fish will be discussed.

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OBSERVATIONS ON THE REFRIGERATED STORAGE OF SUCH FISH AS TUNA, SARDINES, AND MACKEREL ON LAND AND AT SEA

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Some factors involved in the preservation and storage of tuna, sardines and mackerel were investigated. For tuna, those studied included chilling and freezing rates at various temperatures, salt penetration, protein denaturation, loss of protein in brines and the optimum temperature ranges. For sardines and mackerel such factors as optimum chilling temperatures, rates of chilling, heat distribution, and keeping quality were investigated.

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ANTIBIOTICS AS AIDS IN FISH PRESERVATION

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Effects of a number of antibiotics on the keeping quality of fish and shellfish were studied. Some preservative action was noted with Aureomycin, whereas other antibiotics had no significant effect in lengthening the storage time. Effects of the various substances were followed organoleptically and chemically, using the content of Volatile Reducing Substances (VRS) and of Volatile Nitrogen Compounds as indicators of the condition of the fish.

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DISCOLORATION OF PACKAGED FRESH RED MEAT AND ITS RELATIONSHIP TO FILM OXYGEN PERMEABILITY

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Discoloration in packaged fres red meat is caused by a number of factors, of which insufficient oxygen is the most important. This paper attempts, by means of a thorough review of the literature, to explain the mechanisms involved. It also outlines the development of new experimental techniques.

The most rapid color change in fresh beef is the change from the purple red of myoglobin to the scarlet red of oxymyoglobin, the color normally looked for by the consumer. The iron present in both compounds is in the ferrous state, but oxymyoglobin contains loosely bound oxygen, which can be easily removed.

The important color change, as far as merchandising is concerned, is from myoglobin to the brown color of metmyoglobin. This change is a definite oxidation, with the iron being changed to the ferric state. The reaction is not easily reversible.

At normal oxygen pressure (152 mm) oxymyoglobin is formed. Metmyoglobin is not formed until the oxygen pressure falls below 80 mm. At 20 mm. it is formed at its most rapid rate. In wrapped meats metmyoglobin formation is confined to a thin surface layer.

Discoloration caused by dehydration of the meat surface is another factor encountered in meat packaging. This phenomenon is quite common and leads to a surface darkening.

"Dark-cutting" beef is also discussed briefly.

The authors have shown that red meat samples kept under optimum conditions at 35° F. are no longer salable after 4-5 days, because of bacteriological and enzymatic changes, which are inevitable, unless the meat is frozen or subjected to new sterilizing techniques still under study. This maximum shelf-life of 4-5 days sets a definite limit on merchandising possibilities and eliminates the likelihood of packaging at centralized locations remote from the retail outlet.

Oxygen permeabilities of promising candidate films were determined with the apparatus of Landrock and Proctor (*Modern Packaging*, June 1952), with 100% R.H. on the "wettable" side of the cellophane, and 52% R.H. on the coated side, simulating actual meat conditions. Minimum acceptable oxygen permeability values are given. Data on acceptable oxygen permeability levels are also provided. Colored slides will be used

throughout this paper to illustrate the various stages involved in discoloration.

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THE PREPARATION AND STORAGE STABILITY OF FREEZE-DRIED BEEF

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One inch-thick pieces of the muscle *biceps femoris* were freeze-dried by two commercial techniques. Conventional plate freeze-drying was more successful than infra-red radiation. The freeze-dried beef has a pink color and re-hydrates to about 85% of its original moisture. When cooked, the freeze-dried beef was similar to the fresh controls except for a slightly dryer texture and browner color.

During storage at 100° F. the freeze-dried beef undergoes pronounced deterioration. Production of fluorescence, reducing compounds, brown coloration, and a loss of sugars and rehydratability indicate that "amine-active aldehyde" browning is a predominate deteriorative mechanism. The red color of oxyhemoglobin and oxy-myoglobin is lost during storage by an oxidation of the pigments to methemoglobin and metmyoglobin. Storage in atmospheres containing oxygen induces more rapid deterioration involving unsaturated liquid oxidation and other unidentified oxidative reactions.

Storage stability has been increased by (1) packing in pure nitrogen atmospheres to prevent oxidative deterioration, (2) in-package desiccation to lower the water content and thereby decrease the browning reaction, (3) conversion of the heme pigments to their stable carbon monoxide derivatives.

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AMOUNT AND CHARACTER OF CONNECTIVE TISSUE AS IT RELATES TO TENDERNESS IN BEEF MUSCLE

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A study was made to determine the relationship between amount and character of collagenous and elastic fibers in beef muscle that varied widely in tenderness. Nine samples of muscle from each of 52 beef animals that varied widely in age were used. The carcasses were aged approximately 14 days at 0.6-1.7° C. (33-35° F.) cut into their primal cuts and from these the 9 samples were prepared. Each of the samples were tested objectively for tenderness by the Warner-Bratzler shears. Before testing, small cubes of muscle were removed, fixed, and embedded in paraffin. Histological sections were stained to show collagenous fibers, elastic fibers and combination of collagen and elastin. In an attempt to evaluate elastic fibers present, three factors were considered; distribution, amount and size. On this basis the elastic tissue was found to be narrower, more scattered in distribution and of less frequent occurrence in the psoas major muscle for each of the five age groups of animals. The serratus ventralis and deep digital flexor muscles had elastic fibers that were larger and tended to occur in bunches which were too closely massed to estimate their frequency. The findings showed more elastic fibers in the active muscles and fewer in the less used ones. Larger amounts of collagenous fibers were found again in those muscles which were used more extensively, whereas, those with less activity had smaller amounts. In muscles where fatty deposits were evident, the collagenous fibers formed more of a loose network between muscle bundles; while in those with less fat they appeared bunched. These findings agreed closely with the tenderness of the beef muscle.

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THE NATURE OF CERTAIN QUALITY ATTRIBUTES IN MEAT AS REVEALED BY INFUSION

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Previous studies have indicated (1) that tenderness appears to be a function of the actomyosin complex in skeletal muscle and (2) that processing of meat by infusion of chlorotetracycline at slaughter may be used to retard internal spoilage when refrigeration is delayed. Whole animals have been infused with standard curing solutions to produce corned beef possessing unusual qualities of color, tenderness, flavor and lack of dripping following freezing and thawing. These experiments together with other infusion studies using still different solutions point to the close interrelationship between the biochemistry of muscle proteins and meat quality, and to the possibility of modifying the proteins of meat in such a way as to improve certain qualities desired by the consumer.

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WATER-HOLDING PROPERTIES OF BEEF

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The eating qualities of domestic sausages are dependent to a considerable degree upon how much or how well water is "held" in the product. It is commonly believed that meats vary considerably in respect to their water-holding capacities. For instance, bull meat is notorious in being able to "hold" rather large proportions of water. However, there is a need for scientific data to demonstrate this property of meat and the factors which will cause it to vary.

A method wherein comminuted meat is blended thoroughly in an excess of water and then centrifuged under given conditions appears to provide a convenient and accurate measure of the amount of water which can be "held" by different samples of beef.

Data are presented to show the water-holding capacities of beef from different animals and different grades. Data are also presented to demonstrate the effects of adding salt, or curing salts, and storage in the frozen or unfrozen state. Results show that the water-holding capacity is increased by the addition of salt and decreased by the longer storage periods.

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TEMPERATURE DISTRIBUTION PATTERNS DURING PROCESSING OF BEEF AT HIGH RETORT TEMPERATURES

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An investigation was made of temperature distribution patterns in 300 x 308 cans packed with round of beef and processed at higher than conventional retort temperatures for short processing times. The results of this investigation furnish data useful in evaluating the lethality of canning processes when this evaluation is based on the thermal history of the whole container rather than on the history of the geometric center.

Experimental temperature distributions during processing of the containers at 6 retort temperatures ranging from 225-315° F. were determined and found to be in disagreement with the theoretical expectations. The areas of greatest heating lag were found to be displaced from the geometric center of the can and to be located in a doughnut shaped volume (torus) in the central horizontal cross-section of the can. The form of the isothermal lines was found to be cardioid rather than elliptical in shape.

An analysis was made of causative agents for the distorted temperature distributions. The reality of observed temperature distributions was confirmed by an analysis of the distribution of intercept coefficients $[a_n = A_n J_o(\mu r) \sin\lambda (z+1)]$ of the heating equation.

On the basis of the results of this investigation it was concluded that the temperature distributions displaying a doughnut shaped volume (torus) of lowest temperatures in the central horizontal cross-section of the 300 x 308 can are a real occurrence caused by anisotropy of beef and nonuniform initial temperature distribution as reflected by the analysis of intercept coefficients in the heating equation.

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COLD PROCESS JELLIES AND MARMALADE

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A line of products consisting of jellies, marmalade, and cranberry sauce packaged and marketed in individual portions to the institutional trade is produced by a "cold process". These cold process products are distinctive in flavor and color as they have not been overheated, caramelized or deprived of volatile flavoring ingredients.

Fruit and juice ingredients must be of highest quality and possess all of the original flavor character of the fresh material when used in cold process formulas. Strict control must also be maintained over solids, sugar and fruit content and sanitary character of the raw material. Formulae must be carefully devised and strictly observed to produce a product which meets the Federal definitions since the usual boiling to a desired solids content is not practiced. Processing must be especially designed to obtain desired gel strength and to avoid preset in processing lines. Packaging and quality control of this line is also unique and presents its own problems. Illustrative examples of some of the problems encountered and their solution will be given.

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DEVELOPMENT OF A NEW CONCEPT FOR PROCESSING FRUIT JELLY

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The purpose of this investigation was to develop a manufacturing procedure which would result in higher product quality and processing time economy. The basic concept of this new method involved a processing procedure in which a portion of the fruit juice was not subjected to boiling temperatures. The fruit juice for a given batch was divided into 2 or 3 portions but only one was boiled to evaporate the required amount of water. The sugar and pectin were dissolved in another portion at a relatively low temperature. This and a fresh juice portion, when used, were combined with the concentrated portion and the mix heated to the prescribed filling temperature. This innovation was expected to minimize loss of volatile flavors, reduction of jelling power and formation of brown reaction products.

A statistical design known as a "balanced incomplete randomized block arrangement" was used for this research. The experimental process treatments produced an apple jelly which was definitely superior in quality to that produced by the simulated commercial process control. Time economy was realized by using this processing concept. The use of a sucrose-dextrose sugar system resulted in a jelly of significantly better quality than did use of a sucrose-corn syrup solids system.

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STUDIES ON REMOVAL OF THRIPS FROM CANE BERRIES INTENDED FOR PROCESSING

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With the view of improving methods for removal of the insect, thrips, from black or red raspberries intended for canning or freezing, efficiency of various dry and wet methods commonly used for cleaning cane berries was investigated. Several of these methods appeared to be inadequate when the infestation of thrips in the raw material was heavy. A new process involving wetting of black and red raspberries in a solution of 0.1% of a wetting agent (a sodium alkyl aryl sulfonate) prior to the usual water wash was found to remove 85-95% of the thrips, as compared with 40-60% removal by the usual methods. The yield of berries from this cleaning process is essentially the same as the yield obtained by conventional cleaning procedures. Use of detergent does not appear to adversely affect color, texture, or other quality factors of cane berries for freezing. Analyses for residual sulfonate wetting agent has shown results ranging from 0 to 25 p.p.m. Limitations of the analytical method currently used in residue determinations are discussed.

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MOLD COUNTING AS A MEANS OF EVALUATING EFFICIENCIES OF FRUIT WASHING TECHNIQUES

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The mold count technique was used to evaluate the usefulness of detergents in washing strawberries. Problems arising in connection with the selection of samples, methods of washing, preparation of slides, and techniques of mold counting are discussed. A statistical treatment of the results gives additional information on the value of the mold count as a means of judging the quality of processed fruits. In an effort to eliminate the influence of individual vagaries in mold counting several people were used in counting the same slides. Results show the extent of deviation between the mold counts of each person counting.

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VOLATILE FLAVOR OF STRAWBERRIES

I. Identification of the Carbonyls and Certain Low Boiling Substances

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A systematic study of the identities and amounts of the volatile flavoring compounds in strawberries is being made to aid in characterizing the flavor as to quality and potency, and certain phases of the study have been completed. The flavor was separated from fresh Marshall strawberry puree by vacuum flash vaporization of 35% of the water and was concentrated to a 52-fold essence by distillation.

The carbonyl compounds were isolated from this concentrate as their 2,4-dinitrophenylhydrazone derivatives and were separated by chromatography. The identities and amounts of these compounds in terms of total essence were: acetaldehyde 6.1%; 2-Hexenal 9.0%; acetone 3.4%; biacetyl 0.26%. The amount of total essence, calculated from carbon analysis as ethyl alcohol, was about 80 parts per million in the original fruit.

To identify other volatile constituents, the 52-fold essence was concentrated to 850-fold by distillation. The organic components were removed by further distillation in two fractions. One fraction boiled below 85° C. and was found to contain principally ethyl alcohol and smaller amounts of methyl alcohol and organic esters. The other fraction was a water-and-oil mixture which distilled over as a heterogeneous azeotrope below 100° C., and had the typical strawberry aroma. The identity of this oil is under investigation.

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CONCENTRATION OF STRAWBERRY JUICE

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The various problems concerning conversion of strawberry juice into a frozen concentrate have been examined and methods are presented for preparing 5- to 12--fold concentrates containing recovered volatile flavor constituents.

Gelation, which occurs in single-strength juice, appears to be due to deesterification of pectin by the naturally occurring pectinesterase enzyme in the juice to form low-methoxyl pectins which, in turn, react with naturally occurring calcium to form gels. Gelation can be prevented by degrading the pectin with pectic enzyme preparations. Such treatment permits clarification of juice to a sparkling brilliance.

The need is estimated for recovery of volatile flavors prior to vacuum concentration and data included indicate the degree of

evaporation required for adequate recovery of volatile flavors in two types of essence recovery units. Data are given on the effects of batch-wise concentration at various temperatures in a falling-film evaporator upon changes in color and flavor in the product. Under the experimental conditions, the product tends to develop heat-induced flavors and to darken when concentrated at temperatures much over 100° F.

Seven-fold strawberry-juice concentrate prepared by these methods is now commercially available. It is particularly attractive to manufacturers of strawberry products because of the large reduction in freezing, storage, and shipment costs on a solids basis of a product originally containing 90-95% water.

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A STUDY OF COLOR CHANGE IN STORED APPLE JUICE CONCENTRATES

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Full-flavored 68° Brix apple juice concentrates were stored at 5°, 25°, and 37.8° C. Measurements of color density were made at frequent intervals for periods up to a year. The color changes are graphically portrayed by plotting color density against time of storage.

Various treatments were applied to the stripped juice before concentration in an effort to reduce the rate of darkening. Ion-exchange treatment, which effected a considerable reduction in the content of nitrogenous matter, also caused a reduction in rate of darkening. A single pass through a column of cation-exchange resin significantly reduced the browning rate. A subsequent pass through an anion-exchange resin caused a further reduction. In the latter case it was necessary to restore the acidity of the juice by the addition of organic acid in order to have a palatable juice after reconstitution.

The addition of ascorbic acid reduced the rate of darkening at the lower storage temperatures. Sulfite caused a decrease in color and marked inhibition of darkening. Decolorization with carbon was effective, especially when combined with ion-exchange treatment.

Darkening of untreated apple juice concentrate proceeds at a somewhat slower rate when air is excluded during storage. Storage in daylight does not increase the rate of darkening at room temperature.

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FACTORS INFLUENCING THE TEXTURE OF FROZEN CULTIVATED BLUEBERRIES

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With the increasing popularity of commercially cultivated blueberries there has been some discussion as to which method of preparing the berries for freezing would result in the most acceptable frozen product.

Over a three-year period, frozen blueberry packs were prepared as: (1) control pack—no added sirup or sugar; (2) dry sugar pack—4 parts of berries to 1 part of sugar; (3) sirup packs containing from 20 to 60% cane sugar; and (4) water packs. The effect of different blueberry varieties and time of picking on the texture of frozen blueberries was also studied.

The ratings of the frozen packs in decreasing order of desired texture were: 50 and 60% sucrose sirup packs; other sucrose sirup packs; dry sugar (4:1) pack; and water pack. Incorporation of berries from these packs into blueberry pies appreciably reduced the textural differences although the berries from the 50 and 60% sucrose sirup packs retained their individuality to a greater extent than did those from the other packs.

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THE USE OF FRESH FRUIT MATURITY FACTORS TO PREDICT THE QUALITY OF CANNED ITALIAN PRUNES

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There is a distinct need for information concerning the effect of stage of maturity of the canning quality of the Italian prune. This study was undertaken to determine which of several maturity indices of Italian prunes could best be used for predicting canned fruit quality, their approximate values, and usefulness as harvesting guides.

Approximately 200 raw prunes were harvested from each of 5 Italian prune trees near Corvallis, Oregon, every 3 days for 9 consecutive harvest dates. Forty individual fruit from each tree were drawn at random from the 200 and subjected to a series of fresh fruit quality or maturity tests.

For each quality factor which was measured, the experiment was set up as a 9 by 5 factorial analysis of variance study with the number of observations in a replication depending upon the factor being studied.

The correlation of each objective and subjective test with canned fruit flavor is included. The regression line, standard error of estimate and 90% confidence limits were calculated for each test which had a correlation coefficient of 0.80 or better with canned fruit flavor.

Results show that several objective tests used on raw prunes such as soluble solids-acid ratio, pressure test and per cent soluble solids, in the order named, show correlation coefficients of 0.90 or better with flavor of the canned prune. Analysis of variance and L.S.D. of these data indicate they possess good 3-day precision as a guide to harvest maturity. Per cent soluble solids appear suitable for longer time intervals.

Subjective color and flavor of the canned prunes were judged by a statistically selected panel of judges. The correlation between color and flavor of the canned fruit was the highest of the study ($r = +.95$). Indications are that color determinations of Italian prunes can well be substituted for cumbersome taste panels in determining flavor quality of the fruit.

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THE TRANSLOCATION OF SUGARS AND WATER IN CANNED FRUITS

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Six fruit and 5 cover sirup variations were investigated. The experiment was planned statistically to account for individual can and batch variations. Drained weights and sirup cutouts were determined on both fruit and cover sirup up to 3 months of storage. Rate curves for fruit drained weights were interpreted to indicate an initial translocation of water from fruit to cover sirup in order to approach isosmotic conditions. This initial translocation was considered to take place within 24 hours after canning, followed by translocation of sugar and water molecules into the fruit, accounting for an observed increase in drained fruit weights up to 3 months of storage. Statistically significant differences between sirup variations were found for 4 of the fruits with respect to drained fruit weights after 3 months of storage. Sirup cutouts were observed to remain essentially equal and constant for the 5 sirups after one week.

It is proposed from these results that fruits packed in sugar sirups behave like a matrix which permits free movement of water molecules and restricted movement of sugar molecules. The degree of that restriction would determine drained weight differences due to fruit and cover sirup variations.

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PROCESSING CHARACTERISTICS OF TEXAS GRAPEFRUIT

I. Color and Maturity Studies of Ruby Red Grapefruit

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Color is an important variable in processed juice from red grapefruit. It develops in the immature fruit and fades as the fruit approaches maturity. Maximum coloration occurs before the optimum maturity for processing is reached. Lycopene is the dominant pigment influencing color variations. Carotene is present in small amounts in immature fruit and increases slightly as the fruit matures. Naringen was one of the constituents checked in evaluating the maturity of the red grapefruit. Its values are high in the immature fruit. They decrease as the fruit matures but remain relatively constant in the mature fruit.

TABLE 2

Effect of added citric acid on growth of Clostridium pasteurianum in canned Flemish Beauty pears receiving standard process

% Citric acid in added syrup	pH of added syrup	pH of finished product	No. of samples	No. fermented	% fermented
0	7.69	4.4 - 4.6	5	4	80
.1	2.98	4.2 - 4.35	5	4	80
.2	2.70	4.0 - 4.2	4	1	25
.3	2.58	3.85 - 4.0	5	0	0

pears used in this experiment had received maximum storage, with consequent reduction in fruit acid. This probably accounts for the fact that only the higher concentrations of added citric acid showed beneficial results.

DISCUSSION

The results of this study indicate that standard methods of processing are not sufficient to destroy the spores of the strain of *Clostridium pasteurianum* encountered in this work in cases where the pH of the fruit is above 4.25. This agrees with the findings of Townsend *(5)*. Present recommended processes should eliminate spoilage where the pH lies below 4.2, although there is some indication that the standard process might not be adequate for Flemish Beauty pears in the pH range of 4.0 to 4.2. Underprocessing involves a definite risk of spoilage if the pH is in the range from 4.1 to 4.25. Bartlett pears are as a rule sufficiently acid to fall within the safe range, but Flemish Beauty pears being less acid, are subject to spoilage by *Cl. pasteurianum*. It may be noted that in the critical pH range, 4.15 to 4.25, a period of at least 12 minutes at a temperature of 87.8° C. (190° F.) or higher is required to prevent spoilage.

The addition of citric acid to the syrup renders the canned product less liable to spoilage in the case of Flemish Beauty pears. The amount of acid to be added will depend on the stage of maturity of the fruit. As indicated in Table 2 the higher concentration of 0.3% citric acid is necessary if the fruit has been held in storage over an extended period with consequent increase in pH. Fruit in optimum condition should not require the addition of more than 0.2% acid. Acidification of Flemish Beauty pears with citric acid in concentrations not exceeding 0.3% has no adverse effect on flavour, colour or texture.

A possible factor in butyric spoilage of Flemish Beauty pears is the extremely high pH of the core area. Pears with an average pH value of 4.4 may have a core area pH in the neighborhood of 5. Acidification of the syrup assists in the sterilization of these low acid tissues.

The addition of citric acid to syrup pack canned Flemish Beauty pears has been tried on a commercial scale for one season in a factory where butyric fermention has been a serious problem. Fifteen-ounce cans of pears containing 0.2% of citric acid in the syrup were completely free from butyric spoilage. On the other hand untreated solid pack pears showed a high percentage of "butyric swells." This would indicate that acidification of the product, in addition to proper heat processing, is a practical means of controlling butyric spoilage in pears.

In the case of canned tomatoes, acidification does not appear to be a practical means of preventing spoilage by *Clostridium pasteurianum*. Preliminary tests have indicated that in order to lower the pH of canned tomatoes to 4.1, the point at which butyric fermentation may be prevented by standard processes, the large amounts of citric acid usually required made the product unpalatable. The flavour of the acidified product was improved by the addition of sugar, but in no case was it equal to that of the untreated samples. Strict adherence to good factory sanitation, together with thorough washing of the fruit and the employment of recommended sterilization temperatures and times, appears to be the only practical solution to the problem.

SUMMARY

Butyric acid spoilage by *Cl. pasteurianum* in commercially canned Flemish Beauty pears and canned whole tomatoes has been studied. Canned Bartlett pears have not been subject to this type of spoilage.

No spoilage occurred in samples of Bartlett pears buffered to pH values below 4.15, even when underprocessed. At pH 4.5 or higher, however, all samples fermented, even those receiving the recommended commercial processing treatment.

In the pH range 4.15 to 4.25 spoilage occurred only in underprocessed samples of Bartlett pears. Flemish Beauty pears in the range 4.0 to 4.2 showed some spoilage in cans receiving the standard commercial process.

Addition of 0.2% and 0.3% citric acid to the sugar syrup prevented spoilage in canned Flemish Beauty pears in 75% and 100% of samples respectively, with no adverse effect on colour, texture or flavour of the product.

Acidification of a commercial pack of Flemish Beauty pears with 0.2% citric acid in the syrup eliminated losses due to *Clostridium pasteurianum*. Solid pack pears which had not been treated showed a high percentage of spoiled samples.

With canned tomatoes, since acidification is not a practical solution, good sanitary practices in the factory, together with the employment of adequate processing temperatures and times are recommended as possible means of preventing spoilage by *Cl. pasteurianum*.

Acknowledgment

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High Temperature Treatment of Shell Eggs

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Results obtained indicate that short-time, high-temperature treatment of shell eggs effectively prevents microbial spoilage if applied within 24 hours after exposure of eggs to contamination. Most of the experiments reported below were performed by immersion of artificially infected eggs in boiling water for 2 to 3 seconds.

Microbial spoilage of shell eggs has received considerable attention because of increased spoilage caused by washing of eggs. The general subject of the contamination, infection, effect of washing, and spoilage of eggs was thoroughly reviewed in 1939 by Haines *(13)* and has been more recently covered by Lorenz and Starr *(15)* and Gillespie and Scott *(10)*, among many others. It is generally recognized that nearly all eggs are sterile when laid but that subsequent infection may occur, particularly if warm eggs are placed in cool water containing microorganisms. Such conditions may be encountered during washing. Apparently, bacteria gain rapid access to some point in or beneath the shell under such conditions, where they are protected from the action of detergents or germicides applied on the surface of the shell. Here they may remain for some time before subsequently infecting the interior of the egg *(9, 10)*.

Although little attention has been given to treatments of eggs by exposure to high temperatures for short periods of time, two different thermal procedures involving the use of hot water have been suggested. Funk *(5, 6)* employed relatively low temperatures, usually in the time- temperature ranges of 0.5 to 15 minutes and 131° to 158° F. (55° to 70° C.). Although this treatment, usually termed "thermostabilization," is quite effective in controlling spoilage, some thermally induced change occurs throughout the albumen and damage to the angel-cake-baking properties of the albumen occurs under conditions commonly employed *(2)*. Romanoff and Romanoff *(19)* employed boiling water for 5 seconds for the specific purpose of coagulating a thin layer of albumen next to the shell membrane in order to form a protective coating. This treatment is termed "flash pasteurization." Data on microbial spoilage were not presented by these authors, but some direct effects on the organisms in the vicinity of the shell were undoubtedly obtained, in addition to any protective effects afforded by the layer of coagulated albumen.

The most recent and exhaustive study on the general problem of egg spoilage and its control has been published by a team of Australian investigators *(1, 9, 10, 11, 12, 20)*. They found that spoilage can occur from use of contaminated washing water or contaminated washing machines. Spoilage was greatly reduced by subsequent pasteurization in water at temperatures between 135° and 158° F. (57.5° and 70° C.) for 2 to 5 minutes. However, boiling-water treatments for brief periods (2 seconds) were considered inadequate. Evidence in the present paper shows that 2 to 3 seconds' treatment in boiling water prevents nearly all of the fluorescent spoilage of eggs artificially contaminated with a culture of a *Pseudomonas sp.* provided the time interval between exposure and treatment is 24 hours or less.

MATERIALS AND METHODS

The eggs for Experiments A and B were obtained from the Department of Poultry Husbandry, University of California, flock. Eggs with obvious shell defects were rejected, but they were otherwise ungraded. Eggs for Experiments C and D were obtained from a local poultry farm. They were from White Leghorn hens, and were clean, unwashed, large U. S. Grade AA eggs. They were 72 to 120 hours old at the time the experiments were performed in the laboratory.

The Pseudomonas culture (an organism very closely resembling *P. fluorescens*) and the techniques for artificially contaminating the eggs were described by Lorenz *et al. (16)*; the procedure has been termed a "standard" infection technique, since development of fluorescent spoilage in eggs so treated is highly reproducible under defined conditions. It involves pre-warming eggs to 95° F. (35° C.) and immersing them at 59° F. (15° C.) for 5 minutes in a suspension of the described organism containing 10^8 cells per ml.

Exploratory experiments were made with electric grids, a muffle furnace, a flame, and with steam. The temperatures to which the eggs were exposed by the electric grids were approximately 932° F. (500° C.) and by the electric muffle furnace 1832° F. (1000° C.). Flame treatments were conducted by rotating eggs in a glass-blower's multiflame, circular burner. A steam cabinet was employed for the steam treatments. Boiling water immersions were performed simply by dipping eggs into relatively large volumes of actively boiling water in a 50-gallon steam-jacketed kettle. Three dozen eggs supported in a metal lifter were dipped at one time. The lifters were suspended from a hook on a manually operated dipping device consisting essentially of a wooden beam mounted on the side of an upright shaft. Dip times were estimated in Experiment A by a stop watch, but in Experiment B they were recorded on an electrically operated timing device activated by a mercury switch. After the dipping treatments the eggs on the lifters were allowed to drain for 5 to 10 minutes and then placed on clean flats.

Eggs were stored at 56° F. (13.5° C.), which is near the optimum temperature for the development of the fluorescent-sour condition in eggs infected under the "standard conditions" [Lorenz *et al., (16)*]. All eggs were candled with an ultraviolet candler after storage periods of 2.5 to 9 weeks. Fluorescent eggs were removed from the pack and their broken-out contents individually checked under ultra-violet light. At the termination of each experiment, all remaining eggs were broken and the contents examined. In approximately 3,000 eggs, of

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which 500 were fluorescent, only two errors in candling were found. The validity of these data was further checked by bacteriological examinations made on 20 non-fluorescent, infected and treated eggs from experiment D (below). These were made on 0.2 ml. samples of albumen plated in 25 ml. of nutrient broth agar incubated at 59° F. (15° C.) for 4 days. All samples were negative. Haugh units and yolk height were used in the assessments of quality *(13, 21)*.

Coagulation of albumen was estimated visually and by measurement of "holdback." Eggs were broken and allowed to drain. The amount of film or layer of coagulated albumen on the interior of the shell was noted by visual observation and by rubbing the finger along the interior surface. If no coagulation was evident, the residual albumen was scraped from the small end of the shell and allowed to drip from the end of the finger. To estimate yield or "hold-back" of albumen, groups of 6 eggs were weighed and broken out and the contents allowed to drain for approximately 2 minutes. The shells were weighed and the residual albumen was then carefully washed out under cold running tap water. After the shells had been dried overnight, they were reweighed and the difference in weight was termed the albumen hold-back.

Protein denaturation was determined by specific assays for two of the more labile egg-white proteins: conalbumin by means of its iron-binding capacity and lysozyme by means of its bacteriolytic activity *(3, 7, 8)*.

Whipping and angel-cake-baking properties were evaluated according to MacDonnell *et al. (17)* by determinations of the maximum foam volume and maximum cake volume at optimum whipping times.

RESULTS

Introductory trials of different thermal methods. Results of preliminary trials of several methods of thermal exposure are presented in Table 1. Experimental material in each trial was "standard infected" eggs, and heat treatment was performed within a few hours after infection. All heat treatments gave appreciable protection for 2.5 to 3 weeks of storage, while complete protection for the duration of the experiment was obtained with the 3-second exposure to the grids at 932° F. (500° C.), the flaming, and both exposures to boiling water. Experiments with the furnace, flame, and electric grids apparently suffered from at least one major deficiency in that exposure of the surface of the egg was not uniform. This was made evident in electric-grid- and flame-treated eggs by the formation of strips of thickened albumen. Because of the simplicity and the preliminary success of the boiling water treatment, further experiments were carried out with this technique.

Varying time of treatment in boiling water. Experiment C was designed to determine the relative effectiveness of different times of immersion in boiling water. Approximately 1 hour after exposure, lots 2 to 7 were treated by approximately 1, 2, 3, 5, 7.5, and 10 seconds' immersion in boiling water and additional lots by approximately 2 and 6 seconds in steam (see below) and one was held untreated as a control. Each experimental group contained 9 dozen eggs and the control group contained 18 dozen; the sample sizes were chosen from previous experience with the standard infection technique *(16)*. The entire experiment was performed in triplicate with a third of the eggs in each lot treated each time. Identity of the ultimate subgroups was maintained throughout the subsequent storage period. The development of fluorescent spoilage is presented graphically in Figure 1 and the relative efficiency after 9 weeks in Table 2. The partial effectiveness of 1-second treatment and the relatively complete effectiveness of 3 seconds are obvious.

TABLE 1

Effects of high temperature heat treatments on spoilage of eggs by Pseudomonas sp.[1]

Exp.	Heat treatment		No. eggs	Percent fluorescent spoilage after storage for weeks indicated		
	Type	Time		2½	6	9
		seconds		*percent*	*percent*	*percent*
A	None	....	18	66.7	88.8	100
	Electric oven, 1000° C.	1.2-1.3	23	13	43.5	66.6
	Electric grids, 500° C.	2	20	5	70	80
	Electric grids, 500° C.	3	11	0	0	0
				3	6	
		seconds				
B	None	....	12	33.3	66.7	
	Flame, gas	3	10	0	0	
	Flame, gas	5	11	0	0	
	Boiling water	5	11	0	0	
	Boiling water	10	10	0	0	

[1] Eggs infected by procedure of Lorenz *et al.* (1952). In Experiment A the initial temperature of the water during infection was at 4° C. In Experiment B the temperature was at 15° C.

Varying interval between infection and treatment in boiling water. Experiment D was designed to study the effect of the time interval between exposure to infection and treatment.

Eggs were treated in boiling water for approximately 3 (2.7 to 3.3) seconds in 9 dozen lots as in Experiment C, at intervals of 10 minutes and 1, 6, 24, 48, and 72 hours after exposure to infection. An additional 18-dozen lot received no treatment and served as the controls. The development of fluorescent spoilage during storage is given in Figure 2. Even after an interval of 72 hours, an extensive effect was obtained, while up to and including 24 hours, the protection was almost complete.

Smaller groups of eggs were treated for approximately 4 seconds at intervals of 1, 48, and 72 hours. Treatment for the longer period gave at most only slightly better results.

One experiment was performed with the sequence reversed; 9 dozen eggs were treated for 3 seconds in boiling water and

TABLE 2

Effect of extent of treatment in boiling water and steam on interior quality of egg[1]

Lot number	Treatment		Efficiency[2]	Visible coagulation[3]	Albumen hold back[4]		Interior measurements[4]	
	Type	Time			Wt. albumen	Total meat yield	Albumen (Haugh) units	Yolk height
		seconds	*percent*		*g./egg*	*percent*		*cm.*
1	None	....	....	None	1.5	97.3	44	1.69
2	Boiling water	1	77	None	1.6	97.1	47	1.74
3	Boiling water	2	88	Sl. tr.	2.3	95.7	39	1.67
4	Boiling water	3	97	+	2.7	94.9	36	1.60
5	Boiling water	5	98	++	4.9	91.0	22	1.62
6	Boiling water	7.5	100	+++	5.4	89.9	37	1.57
7	Boiling water	10	100	++++	7.1	87.0	26	1.61
8	Steam	2	33	Sl. tr.	1.8	96.6	59	1.74
9	Steam	6	76	++	3.6	93.0	49	1.56

[1] Eggs were from Experiment C described in text and partially presented graphically in Figure 1. Visible coagulations were determined 24 hours after treatment. All other examinations were at termination of storage for 9 weeks at 15° C.

[2] Efficiency as here used refers to relative effectiveness in preventing development of Pseudomonas spoilage that would have otherwise developed.

[3] When a few specks or strands of coagulated albumen were seen, the amount of coagulation was judged "slight trace" (sl. tr.). When coagulation was just evident by close observation of the inside of the shell, coagulation was judged a one plus.

[4] Measurements are averages of from 8 to 12 eggs in each lot.

subsequently (1 hour afterwards) were exposed to the standard infection technique. This experiment was performed because of the possibility that protein denaturation might increase susceptibility to infection and because of Romanoff's emphasis on the "protective" film produced by boiling water. As compared to the rate of development of spoilage in the controls, eggs given this

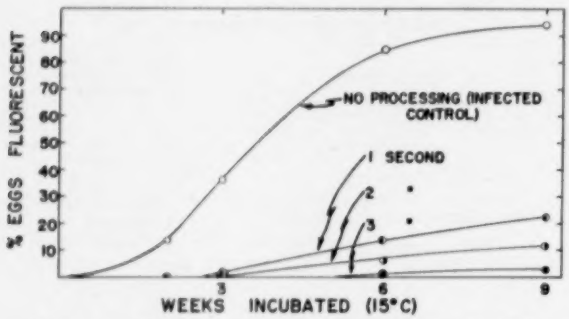

Figure 1. Effect of varying processing times in boiling water. Eggs were infected by standard procedure of Lorenz et al. (16) and were treated approximately one hour after infection.

treatment showed some protection after 3 weeks' storage (Figure 2). However, after 7 and 9½ weeks, the treated eggs showed nearly as much spoilage as the controls. The spoilage percentages in the controls at 3, 7, and 9½ weeks were, respectively, 58, 80, and 94% (Figure 2), and 32, 75, and 84% were found in the pretreated group.

Effect of treatment in boiling water on quality, grades, and properties. At the termination of Experiment C, quality studies were made on a portion of the unspoiled eggs. In Table 2 are listed the effect of time of treatment on the visible coagulation inside the shell, the albumen hold-back, yolk height, and Haugh units. Treatment for 1 second was without any detectable effect on any of these quality factors. Treatment for 2 seconds gave a slight but detectable effect on visible coagulation and hold-back, while 3 seconds gave a definite effect on both of these measurements. There was no apparent effect on albumen or yolk quality with treatments of 3 to 5 seconds (Table 2). This conclusion was confirmed in a supplementary experiment on 32 uninfected eggs stored for a similar period.

In Experiment D additional eggs were set aside for immediate quality measurements: albumen hold-back, candling grade, functional properties, and protein assays. The hold-back data (Table 3) agree closely with those of Experiment C. A slightly lowered candle grade was found but whether or not this difference was significant and has any practical importance would require study with larger numbers of eggs. A real difference was noted, however, in the manner in which the 3-second-treated

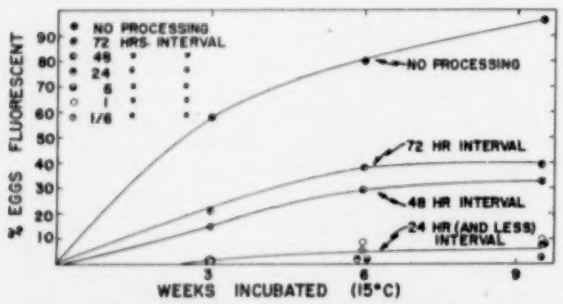

Figure 2. Effect of time interval between infection and processing. Eggs were infected by standard procedure of Lorenz et al. (16) and were treated in boiling water for approximately 3 (2.7-3.3) seconds.

eggs behaved on breaking. Their shell membranes were apparently a little stronger than those of untreated eggs; individuals breaking them rated them "fresher" and "stronger."

No significant differences were noted in the whipping and angel-cake-making properties of the albumen of 3-second-treated eggs (Table 4). (Similar results were also obtained with some badly coagulated eggs from the flaming experiments.) Confirmation of the very slight denaturation of albumen proteins was obtained by specific assays for integrities of the conalbumin and lysozyme constituents. Similar data were obtained with albumen separated from control and 3-second-treated eggs. Of course, some denaturation occurs near the shell membrane, but percentage-wise it is obviously small.

Effect of treatment with steam. Steam was investigated with only 18 dozen eggs as part of Experiment C (Table 2). Steam treatment for 6 seconds was approximately as effective as boiling-water treatment for 2 seconds, but paradoxically, the production of visible coagulation and albumen holdback was greater than with 3 seconds in boiling water.

TABLE 3

Effect of treatment in boiling water on candle grades and quality of eggs [1]

Lot no.	Time in boiling water	Albumen hold back [2]		Candle grades			
		Wt. albumen	Total meat yield	No. eggs	Grades found [3]		
					AA	AB	Other
	seconds	*g./egg*	*percent*		*per cent*	*per cent*	*per cent*
11	2.8	3.3	94.7	66	68	27	5
12	3.6	4.6	92.6	33	71	26	3
13	None	1.8	97.3	71	79	18	3

[1] These eggs were control (uninfected) eggs from Exp. D discussed in text and presented in part graphically in Figure 2. Determinations were made within 72 hours of treatment.

[2] Determined as described in text. "Hold back" refers to the albumen which does not freely and quickly run from shell when egg is broken out. Figures are average for 6 eggs in each lot.

[3] Candling performed by licensed U. S. Department of Agriculture inspector.

TABLE 4

Effect of treatment in boiling water on functional properties of albumen

Whipping time, seconds	Untreated [1] (lot 13, Exp. D)			Treated [1] (lot 11, Exp. D)		
	Meringue Sp. gravity	Batter Sp. gravity	Angel cake volume	Meringue Sp. gravity	Batter Sp. gravity	Angel cake volume
			ml.			*ml.*
11	0.17	0.29	720	0.18	0.28	740
13	0.17	0.27	730	0.17	0.27	730
13	0.17	0.26	690	0.18	0.28	720
17	0.17	0.27	660	0.17	0.27	690
25	0.15	0.24	620	0.16	0.25	660

[1] Eggs were uninfected controls from Exp. D, which is discussed in text and partially presented in Figure 2. Untreated and treated were from lots 13 and 11 (2.8 seconds) of Table 3.

DISCUSSION

The initial purpose of this study was to determine whether or not short-time, high-temperature thermal treatment of shell eggs soon after exposure to infecting bacteria could materially reduce the subsequent development of infection without seriously damaging the interior quality of the eggs. Under laboratory conditions and with the particular organism employed, the data support the conclusion that the initial purpose was achieved.

The Australian investigators concluded that high-temperature (boiling-water) treatment was not very

effective in controlling rotting of machine-cleaned eggs *(20)*. However, since most of their experiments were performed more than 48 hours after washing, their data are not in essential disagreement with ours. Gillespie and Scott *(10)* theorized that during wet cleaning bacteria may pass immediately to points in the shell very close to the shell membrane but then only slowly attack the membrane and reach the albumen. High-temperature treatment applied soon after exposure might therefore be expected to intercept this sequence of events (before infection of the albumen) either by thermally killing the bacteria or by some less obvious means such as expelling most of them out through pores.

Since the completion of our study a patent has appeared proposing the treatment of eggs with sterilizing water or steam after wet-sand cleaning *(18)*. Our results would indicate a preference for the water treatment rather than the steam.

In general, the results with boiling water were striking and clear-cut under laboratory conditions. The relative ineffectiveness of the steam treatment is difficult to explain in terms of a thermal killing mechanism. Although treatments with dry heat, particularly the furnace treatments at 1000° C., were less effective, they were considered encouraging. Tests should be made with equipment designed to treat eggs properly at this temperature.

It must be emphasized that this study was not performed under practical commercial or farm conditions. Adequate commercial and farm studies are mandatory to evaluate the practical significance and utility of short-time high-temperature treatment. The studies should be extended to include different organisms, particularly those of possible public health significance such as Salmonellae. Evaluation should also be made of its utility for reduction of microbial counts in commercial liquid and dried egg products when applied immediately prior to breaking-out the eggs.

SUMMARY

High temperature treatment of shell eggs for short periods of time reduced greatly the development of a fluorescent *Pseudomonas* sp. in artificially contaminated eggs. The treatment temperatures were varied between 212° and 1832° F. (100° and 1000° C.) and times of exposure between 0.5 and 10 seconds. Time intervals between infection and treatment were varied from 10 minutes to 72 hours.

Most of the experiments were performed at 212° F. (100° C.) by immersion of eggs in boiling water, because of its simplicity and effectiveness. Almost complete protection against fluorescent spoilage was obtained when the immersion time was 2 to 3 seconds and the time interval between infection and immersion was 24 hours or less. Eggs treated for 2 seconds showed no important changes in appearance of the intact or broken-out eggs or in the functional properties of the egg white.

These results indicate that short-time, high-temperature treatment may be effective if applied soon after shell infection. Adequate commercial and farm trials of the process are mandatory to evaluate its practical significance and utility.

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Effect of Low Freezer Storage Temperature and Wrapping Material on the Quality of Frozen Meats

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This study was designed to compare the keeping quality of hamburg, bacon and sausage at the usual home-freezer temperature (0° F.) with samples stored at lower temperatures (—20° F., —30° F. and —40° F.). By lowering the freezer storage temperature, the development of rancidity was found to be retarded and these findings were confirmed by organoleptic tests. However, the hamburg in this study did not show significant rancidity until it had been stored for more than one-half year at 0° F.

Aluminum foil and glassine-laminated paper both retarded the development of rancidity of each kind of meat at each storage temperature, when compared with samples wrapped in polyethylene-coated paper and in butcherwrap of good quality.

Moisture loss was insignificant at any storage temperature when aluminum foil, polyethylene-coated paper or glassine-laminated paper were used. The samples in butcherwrap showed rapid loss of moisture at 0° F., but decided protection was noted when the storage temperature was —20° F. or lower.

Because of the superior quality of frozen foods compared with foods preserved by other methods, and also because of their convenience, home freezers are more and more popularly used in recent years. Another merit recognized in preservation by freezing is the financial savings which can be anticipated, and this feature is of special interest in the freezing of meats from animals raised at home or purchased at wholesale prices.

The storage temperature of most freezers on the current market is approximately 0° F. Many factors affect the time for which meats may be stored satisfactorily at this temperature and it is, therefore, impossible to state definite periods for which different meats will remain in good condition. However, following are some recommendations to the consumer for storage periods (in months) of samples of "average" quality held under "average" storage conditions: beef and lamb—8-12; poultry—6-12; fresh pork—4-6; ham and bacon—2-4; lean fish—6-8; fatty fish—4; variety meats—4.

The production and wholesale prices for meats are often seasonal and the short periods of storage recommended for numerous meats makes it impossible to hold them in freezer storage as long as desired. This factor reduces the practicability of significant financial savings in freezing them.

Lowering of freezer storage temperature has been found to be effective in depressing rancidity development *(2, 3, 5)*; in retarding flavor deterioration *(9, 12, 13)*; or both *(1, 6, 7, 8, 10)*. Tenderness and juiciness have also been found to be better retained by lowered storage temperatures, although these changes have been found to be affected to a lesser degree by freezer storage *(12, 13)*. Some manufacturers of home freezers have indicated to the authors the possibility of providing freezers with temperatures somewhat lower than 0° F. without greatly increasing the cost. It was the intention of this study to provide experimental data showing the relative effectiveness of freezers maintaining these storage temperatures in preserving the desirable qualities of certain meats. It was also of interest to learn whether the lower freezer storage temperatures would make practicable the use of packaging materials less expensive than those recommended for use in freezers maintaining a temperature of 0° F.

MATERIALS AND METHODS

Hamburg. Using beef carcasses from a local plant of Swift and Company, approximately 100 pounds of meat of commercial grade was trimmed from 2 chucks and 2 plates from 4 different animals. To provide fat content comparable to that of good quality hamburg on the retail market, white pieces of suet were selected from a large batch of fresh trimmings from different animals; they were added to the meat during grinding and mixing to insure even distribution. The hamburg was then taken immediately to the laboratory.

Sausage meat. Approximately 100 pounds of ground sausage meat was obtained from one hog carcass shipped from Swift and Company in Chicago. Skin and bone were removed from the carcass, then fat and lean tissues of the entire carcass were ground together and thoroughly mixed. No seasonings were added. The sausage meat was taken immediately to the laboratory.

Bacon. Eight sides of Swift Premium bacon of unknown animal origin were shipped from Swift and Company in Chicago especially for this study. They had been uniformly sliced before being shipped.

Analytical data on fresh meats. Four representative samples from each kind of meat were used for determining moisture content by oven-drying and for determining fat content by solvent extraction with the Soxhlet apparatus. Their pH values were determined by blending with a small amount of distilled water and reading the pH values directly from a pH meter. Results are summarized in Table 1.

TABLE 1
Moisture content, fat content and pH value of meats before freezing

Kind of meat	Moisture content	Fat content	pH
	%	%	
Hamburg	56.8	24.5	5.98
Sausage	37.4	52.2	6.49
Bacon	20.2	69.1	6.18

Packaging materials. Four different packaging materials were employed; a heavy aluminum foil, a glassine-laminated paper, a polyethylene-coated paper and a butcherwrap of good grade. The wrappings were tested in the Paper Testing Laboratory, New York State College of Forestry; their characteristics are summarized in Table 2.

Methods of packaging and freezing. All meats were handled carefully to avoid contamination, and except for the small portions at a time which were being weighed and packaged at room temperature, they were kept under refrigeration until time of

TABLE 2
Characteristics of wrapping materials

Type of wrapper	Basis wt. (3000 sq. ft.) 24x36/ 500 lbs.	Burst test p.s.i.	Burst ratio percent	Tear test grams	Tear ratio percent	Thickness mils.	Cobb size (gm./100 sq.cm./ 2 min.)		Vapor transmission (gm./100 sq.cm./ 24 hrs.)		Fiber composition
							Treated side in contact with H_2O	Untreated side in contact with H_2O	Treated side in contact with H_2O	Untreated side in contact with H_2O	
Aluminum Foil	64.5	33.4	51.8	56.4	87.4	1.4	0.007		0.0192		100% Aluminum
Glassine-Laminated Paper	76.2	37.5	49.3	81.1	106.4	4.7	0.194	0.208	0.266	0.170	100% Unbleached Sulphite laminated with wax to 100% Bleached Sulphite
Polyethylene-Coated Paper	54.1	39.1	72.3	95.4	176.1	3.6	0.010	0.325	0.166	0.307	100% Bleached Sulphite coated with Polyethylene
Butcherwrap	46.5	31.6	68.0	49.2	105.8	3.7	0.146		1.558		100% Bleached Sulphite

NOTE: Burst Ratio = Burst Test ÷ Weight per Ream (24 x 36/500) x 100.
Tear Ratio = Tear Test ÷ Weight per Ream (24 x 36/500) x 100.

freezing. For each kind of meat, the entire portion was in the freezers within 8 hours of the time it arrived in the laboratory.

Hamburg and sausage meat were packaged (drugstore-wrap method) in 100-g. portions weighed to the nearest gram.

No information was available as to the source of the sides of bacon, and they may have come from different animals and from different curings. A sampling method taking these facts into consideration was necessary. The 8 sliced sides were all cut lengthwise into 4 columns and the columns were numbered as indicated in Figure 1. Eight quarter-slices were used in each

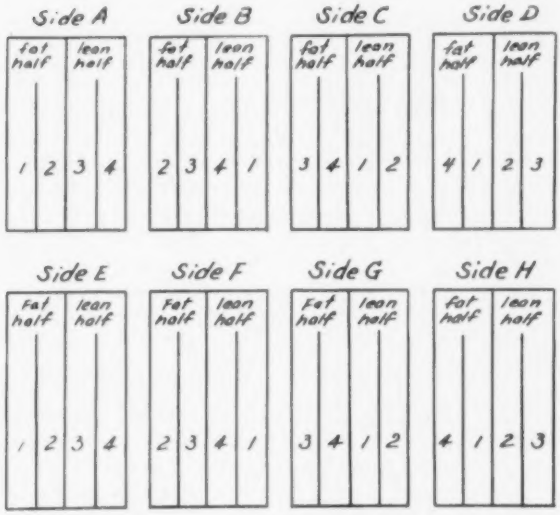


Figure 1. Arrangement of bacon sides before packaging.

package, one from each of the 8 sides and from positions all marked with the same number, whether it was 1, 2, 3, or 4. In each package there was thus a total of 2 slices, including an equal number of fat and lean quarter-slices. The weight of bacon per package was approximately 50 g., and the drugstore-wrap method was used for packaging.

Samples of each kind of meat, in each kind of packaging material, were frozen and stored in 4 freezers maintaining temperatures of 0° F., —20° F., —30° F. and —40° F. As soon as samples were packaged they were placed in single layers in the freezers overnight. The following morning they were stacked in baskets for storage.

Moisture loss during storage. The moisture proofness of the 4 packaging materials was studied with hamburg at the 4 different storage temperatures. Five 100-g. samples were used for each kind of wrapping at each storage temperature. They were weighed to the nearest tenth of a gram, immediately before and again after packaging, and were then frozen. During the 2-year storage period, these packages were weighed at intervals, first every 2 weeks, then every month and finally every 2 months as the moisture loss became less rapid. Samples were weighed in their packages, and the percentage moisture loss in each case was the average of 5 samples. Condensed moisture was inevitably deposited on the surface of the packages during storage, and could not be removed readily for weighing. To help solve this problem, each package was overwrapped with very thin, porous tissue paper which was removed immediately before weighing and replaced with fresh tissue paper after weighing. These tissues were not believed to interfere with the purpose of the study, since all samples were treated alike and the interest was in relative rather than absolute moisture losses.

Rancidity development. This was noted by the determination of peroxide oxygen with the slightly modified Wheeler's method *(11)*. The peroxide value was expressed as milli-equivalents of active oxygen (peroxide oxygen) per 1000 g. of fat extracted from the meat samples. Determinations were made at intervals during the entire storage period of 50 weeks for bacon, 23 months for sausage meat and 24 months for hamburg, using samples wrapped in polyethylene-coated paper and in butcherwrap. For samples wrapped in glassine-laminated paper and in aluminum foil, determinations were made only once at the end of the storage period for each kind of meat.

Flavor changes during storage. Flavor changes in meats were judged by organoleptic tests, using the paired-eating method *(4)*. To note the effect of storage temperature, 3 tests were originally planned; one after the samples at 0° F. showed a significant increase in peroxide value, one after those at —20° F. showed increased peroxide value, and the third after those at —30° F. showed increased peroxide value. However, peroxide development was slower than expected, and so the original plan was modified. Thus, for hamburg, only 2 organoleptic tests were conducted, because no sample had developed rancidity even at the end of the 2-year storage period. For each test, a sample stored at —40° F. was used as the standard and was compared with a sample stored at a higher temperature. All meats were thawed in the refrigerator overnight, were cooked in pairs, and served hot. Drippings from bacon were poured off during cooking and were served hot to the judges with the bacon. For noting the effect of storage temperature, samples in the same kind of wrapping material but from different freezers were compared.

To note the effect of packaging material, samples from the same freezer but in different wrappers were compared. At the end of the storage period for each kind of meat, samples in polyethelene-coated paper were compared with those in other wrappers. In addition, samples in butcherwrap were compared with those in polyethylene-coated paper at one or 2 earlier

periods (at the time that tests were made for noting the effect of storage temperature on flavor). Also, a few samples stored in glass (petri) dishes were included in this part of the study. Meats were thawed and cooked for these tests by the same method as that used for noting the effect of storage temperature on flavor.

In all organoleptic tests, judges were asked to compare the paired samples as to flavor (odor as well as taste) and to give their preference between the samples on a judging sheet. They were also asked to score the two samples with five descriptive adjectives, excellent, good, acceptable, slightly "off" and rancid, and these terms were given numerical scores of 5, 4, 3, 2 and 1, respectively. For all tests, at least eight judges were employed.

RESULTS AND DISCUSSION

Moisture loss from hamburg. A summary of moisture losses is presented in Table 3. The values are expressed as percentage weight change, in which a negative value indicates loss and a positive value indicates gain.

Moisture loss from hamburg was found to be significant only when the samples were packaged in butcherwrap. About one-half of the water content was lost by the end of 2 years' storage. Definite surface desiccation was noticeable after only a few weeks of storage at 0° F., but lowering the storage temperature greatly reduced the moisture loss. Decreasing the storage temperature from 0° F. to —20° F. reduced the moisture loss from 30% to 6% at the end of 2 years. The effectiveness of different low-storage temperature in protecting against moisture loss is shown in Figure 2.

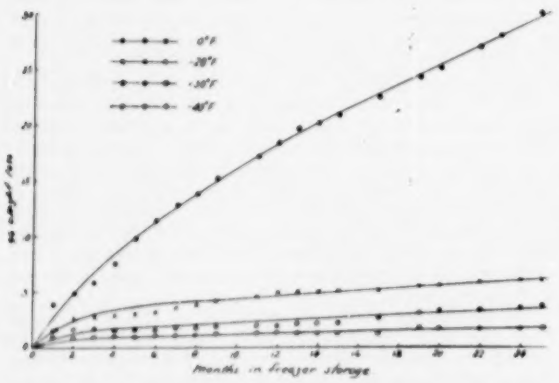


Figure 2. Effect of freezer storage temperature on moisture loss of frozen hamburg packaged in butcherwrap.

Small moisture losses were also found from the samples in the other 3 wrappings (polyethylene-coated paper, glassine-laminated paper and aluminum foil) stored at 0° F., but the loss was less than 2%. Almost no loss was found from samples in these wrappings when stored at lower temperatures.

The occasional small gain in weight was probably due to condensed moisture under the folds of the wrapping material, which was difficult to remove completely during weighing. It appeared that the largest amount of moisture condensed on the polyethylene-coated paper, no doubt due to its surface quality. Hence, the slightly lower weight loss of samples in this wrapper compared with that in aluminum foil (as shown in Table 3) does not necessarily indicate that the former was more moisture-proof.

Effect of storage temperature on rancidity development. Rancidity development was indicated by the peroxide value which was zero for all meats at the beginning of the study. Results are presented in Figure 3.

TABLE 3

Percentage weight change[1] of hamburg as a result of moisture loss after two years storage in freezers at various temperatures with different wrappings

Wrapping materials	Freezer temperature ° F.			
	0	—20	—30	—40
	%	%	%	%
Butcherwrap	—30.0	—6.2	—3.8	—1.7
Polyethylene-coated paper	—0.1	+1.3	+0.2	+0.7
Glassine-laminated paper	—1.5	+0.2	+0.2	±0.0
Aluminum foil	—0.6	±0.0	+0.1	±0.0

[1] A negative value indicates weight loss and a positive value indicates weight gain during storage.

As indicated in Figures 3b and 3e, the —20° F. freezer went out of order during one weekend about 80 weeks after the study had begun. At the time this was discovered, samples were partially thawed. Apparently this had some effect on the peroxide development in samples of sausage meat in that freezer, since a more rapid increase in peroxide value followed that period. As a result of this accident, the peroxide value of the sausage meat in the —20° F. freezer finally became equal to those of the samples in the 0° F. freezer. Re-

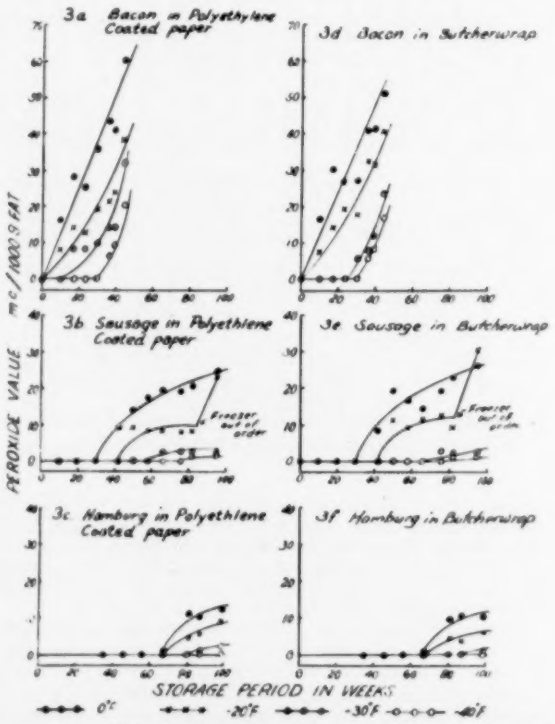


Figure 3. Effect of storage temperature on rancidity development of meats wrapped in polyethylene-coated paper and butcherwrap.

sults do not indicate any appreciable effect from the accident with the hamburg samples.

Samples in polyethylene-coated paper. Bacon stored at 0° F. probably developed peroxides very early in the storage period, since it was found to have an average peroxide value of 14 when it was first determined after 10 weeks. It increased continuously during storage and reached a value of between 50 and 60 milli-equivalents per 1000 g. of extracted bacon fat at the termination of the bacon study (45 weeks). Development of peroxide was retarded when the storage temperature was decreased; and the lower the storage temperature, the higher was the degree of protection. When the study terminated, the average peroxide values were 55, 40, 28 and 15 milli-equivalents per 1000 g. of extracted bacon fat from the samples at 0° F., —20° F., —30° F. and —40° F., respectively. If a peroxide value of 10 is arbitrarily selected as the rancid point (where samples show a noticeable rancid flavor), then bacon in the 0° F. freezer reached this point in 6-9 weeks; in the —20° F. freezer in 12-15 weeks; in the —30° F. freezer in 30-35 weeks; and in the —40° F. freezer in 37-42 weeks.

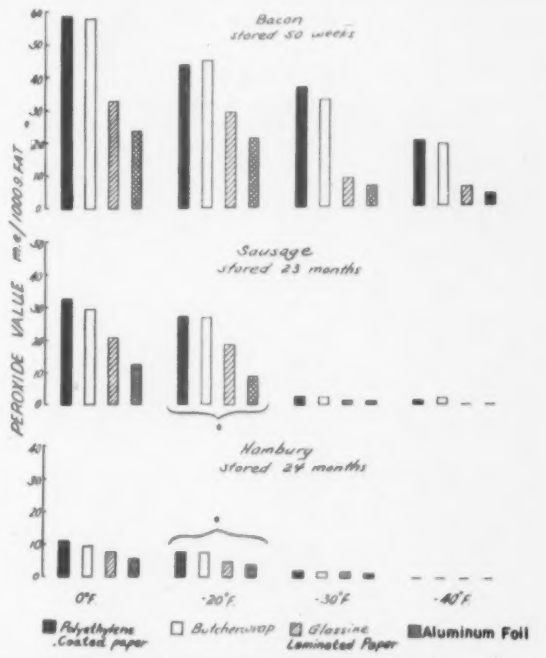
Samples of sausage meat did not show any sign of peroxide development until after 30 weeks of storage at 0° F., or until after 40 weeks at —20° F. The value increased steadily afterwards, but the increase was less rapid than for corresponding bacon samples. The peroxide value was only 30 after 95 weeks of storage in the 0° F. freezer. Sausage meat in the 0° F. freezer reached the arbitrarily selected rancid point (peroxide value of 10) in about 45-55 weeks, and those in the —20° F. freezer reached this point in 75-85 weeks. Samples stored at —30° F. and —40° F. showed only traces of peroxide (value of less than three) even at the end of the study with a storage time of 95 weeks.

Development of peroxide among the hamburg samples was very slow. No sign of peroxide was detected after the samples had been stored for 65 weeks. After that, peroxide began to develop slowly in samples stored at 0° F. and reached the arbitrarily selected rancid point of 10 after approximately 80 weeks of storage. Samples in the —20° F. freezer developed peroxide somewhat later, but did not reach the value of 10 even when the study terminated. Development of peroxide was insignificant for samples stored at —30° F. and —40° F. throughout the entire storage period of approximately 2 years.

Samples in butcherwrap. Findings similar to those mentioned above for samples wrapped in polyethylene-coated paper were obtained from samples in butcherwrap.

Effect of wrapping material on rancidity development. Comparative protection against rancidity development in frozen bacon, sausage meat and hamburg by the 4 kinds of wrapping material used in this study is indicated by bar graphs in Figure 4. The lengths of the bars represent the average peroxide values of triplicate determinations at the end of the storage period for each kind of meat in each kind of wrapping material. Here again, samples stored at the highest temperature had the highest peroxide value. Among the samples stored at any one temperature, those wrapped in aluminum foil showed the lowest peroxide value, those in glassine-laminated paper the next, while little difference was found between those in polyethylene-coated paper and those in butcherwrap.

Effect of storage temperature on flavor. Relationships between the storage temperature and flavor of



* Freezer(-20°F) out of order at 80 week period (see text)

Figure 4. Effect of wrapping materials on rancidity development of meats at various storage temperatures.

meats are summarized in Table 4. Samples of each kind of meat at 0° F., —20° F. and —30° F. were compared with corresponding samples at —40° F. at appropriate intervals as indicated under "storage period." The number of judges who preferred the control (sample at —40° F.) and those who preferred the sample under consideration was recorded and the difference was analyzed statistically by Chi-square *(4)*.

As shown in Table 4, when bacon samples were tested after 11 and after 23 weeks of storage, only those at 0° F. were significantly poorer in flavor when compared with corresponding samples at —40° F. Highly significant differences were found between the samples at —40° F. and those at both 0° F. and —20° F. when tested again after 39 weeks of storage. However, even at this time, differences between samples at —30° F. and —40° F. were still not statistically significant.

Samples of sausage meat were compared as to flavor at storage periods of 10, 17 and 22 months. After 10 months, although more judges preferred samples at the lower temperatures, none of the differences were statistically significant. Samples from the 0° F. freezer became significantly poorer than those from the —40° F. freezer when tested after 17 months. Samples from the —20° F. freezer were significantly poorer than those

from the —40° F. freezer when tested after 22 months, and at this time the difference between the samples from the 0° F. freezer and those from the —40° F. freezer was highly significant. The differences between the samples from the —30° F. freezer and those from the —40° F. freezer were only slight for any of the 3 testing periods.

Hamburg samples at all storage temperatures showed good flavor throughout the entire 2-year storage period,

TABLE 4

Effect of storage temperature on flavor of frozen meats Based on preference with paired-eating method (Samples at —40° F. used as control)

Kind of meat	Experimental storage temperature	Storage period	Total number of judges	Percent of judges preferred samples stored at experimental temperature over control	Chi-square[1]
	° F.			%	
	0	11 weeks	8	12.5	4.5[2]
		23 weeks	8	12.5	4.5[2]
		39 weeks	8	0.0	8.0[3]
Bacon	—20	11 weeks	8	50.0	0.0
		23 weeks	8	37.5	0.5
		39 weeks	12	8.3	7.3[2]
	—30	11 weeks	16	53.0	0.1
		23 weeks	8	43.8	0.1
		39 weeks	8	25.0	2.0
	0	10 months	8	25.0	2.0
		17 months	8	12.5	4.5[2]
		22 months	8	0.0	8.0[3]
Sausage	—20	10 months	8	25.0	2.0
		17 months	8	25.0	2.0
		22 months	8	12.5	4.5[2]
	—30	10 months	8	50.0	0.0
		17 months	8	31.2	1.1
		22 months	8	43.8	0.1
Hamburg	0	16 months	8	37.5	0.5
		22 months	8	37.5	0.5
	—20	16 months	8	37.5	0.5
		22 months	8	43.8	0.1
	—30	16 months	8	37.5	0.5
		22 months	8	43.8	0.1

[1] Chi-square below 3.841 is not significant; 6.635 is usually considered highly significant for one degree of freedom as here.
[2] Significant difference.
[3] Highly significant difference.

and therefore little difference was found when any of them were compared with the samples from the —40° F. freezer, after 16 and after 22 months of storage.

The flavor of frozen meats at various temperatures was also scored by the descriptive adjectives given by the judges at the time their decisions were made on their preference. Methods of weighting and averaging were essentially those described by Cover *(4)*. Average scores for all samples are presented in Table 5, along with the average scores of their controls rated at the same time by the same judges. Since the judges were not the same persons for all tests, and since a given judge may vary his judgment from time to time, the scores should not be considered as absolute values. However, samples showed a decrease in scores during the storage period and this decrease was more rapid at higher storage temperatures. The exception to this was

TABLE 5

Flavor scores of frozen meats stored at various temperatures (Samples wrapped in polyethylene-coated paper stored at —40° F. used as control)

Based on descriptive adjectives with paired-eating method

Kind of meat	Storage period	Storage temperatures of samples compared in pairs	Average score
Bacon	11 weeks	0	3.22
		—40	3.89
		—20	3.50
		—40	3.50
		—30	4.38
		—40	4.00
	23 weeks	0	2.38
		—40	4.13
		—20	2.22
		—40	3.38
		—30	3.38
		—40	4.13
	39 weeks	0	1.88
		—40	3.75
		—20	2.58
		—40	4.08
		—30	3.50
		—40	4.13
Sausage	10 months	0	2.38
		—40	3.50
		—20	2.08
		—40	3.38
		—30	3.00
		—40	3.00
	17 months	0	2.62
		—40	3.62
		—20	2.38
		—40	4.00
		—30	2.08
		—40	3.62
	22 months	0	2.38
		—40	3.35
		—20	2.38
		—40	4.00
		—30	3.62
		—40	4.13
Hamburg	16 months	0	3.13
		—40	3.50
		—20	3.13
		—40	3.75
		—30	3.75
		—40	4.13
	22 months	0	3.50
		—40	3.75
		—20	3.38
		—40	3.38
		—30	3.62
		—40	4.00

in the scores of samples stored at —40° F. These samples showed an increase in score, no doubt because they were compared with samples of poorer quality as the storage period progressed.

Effect of wrapping material on flavor. The flavor of frozen meats packaged in various wrapping materials was compared at the termination of the study for each

meat, using the sample in polyethylene-coated paper as the standard for comparison. Samples in butcherwrap were also tested at 2 earlier storage periods. Results are presented in Table 6, with statistical analysis by Chi-square. In general, more judges preferred the samples wrapped in aluminum foil and in glassine-laminated paper (as compared with those in polyethylene-coated paper) but the differences were only significant after the corresponding samples had deteriorated to a noticeable degree. Preferences between samples in poly-

TABLE 6

Effect of wrapping materials on flavor of frozen meats Based on preference with paired-eating method (Samples wrapped in polyethylene-coated paper used as control)

Kind of meat	Storage temperature	Experimental wrapping material used	Storage period	Total number of judges	Percent of judges preferred samples in experimental wrappings over control	Chi-square[1]
	°F.				%	
Bacon	0	Butcherwrap	11	8	50.0	0.0
		Butcherwrap	23	8	31.3	1.1
		Butcherwrap	39	8	31.3	1.1
		Glassine-laminated paper	50	8	87.5	4.5[2]
		Aluminum foil	50	8	93.8	6.1[3]
	−20	Butcherwrap	11	8	25.0	2.0
		Butcherwrap	23	8	18.8	3.1
		Butcherwrap	39	8	25.0	2.0
		Glassine-laminated paper	50	8	43.8	0.1
		Aluminum foil	50	8	68.8	1.1
	−30	Butcherwrap	11	8	25.0	2.0
		Butcherwrap	23	8	50.0	0.0
		Butcherwrap	39	8	50.0	0.0
		Glassine-laminated paper	50	8	68.8	1.1
		Aluminum foil	50	8	93.8	6.1[3]
	−40	Butcherwrap	11	8	37.5	0.5
		Butcherwrap	50	8	68.8	1.1
		Glassine-laminated paper	50	8	68.8	1.1
		Aluminum foil	50	8	50.0	0.0
Sausage	0	Butcherwrap	10	8	27.5	0.5
		Butcherwrap	17	8	50.0	0.0
		Butcherwrap	23	8	81.3	3.1
		Glassine-laminated paper	23	8	67.5	0.5
		Aluminum foil	23	8	100.0	8.0[3]
		Glass	23	8	81.3	3.1
	−20	Butcherwrap	10	8	43.8	0.1
		Butcherwrap	17	8	31.1	1.1
		Butcherwrap	23	8	62.5	0.5
		Glassine-laminated paper	23	8	50.0	0.0
		Aluminum foil	23	8	68.8	1.1
		Glass	23	8	81.3	3.1
	−30	Butcherwrap	10	8	27.5	0.5
		Butcherwrap	17	8	27.5	0.5
		Butcherwrap	23	8	50.0	0.0
		Glassine-laminated paper	23	8	50.0	0.0
		Aluminum foil	23	8	68.8	1.1
		Glass	23	8	50.0	0.0
	−40	Butcherwrap	23	8	56.3	0.1
		Glassine-laminated paper	23	8	56.3	0.1
		Aluminum foil	23	8	43.8	0.1
		Glass	23	8	50.0	0.0
Hamburg	0	Butcherwrap	16	8	31.3	1.1
		Butcherwrap	24	8	25.0	2.0
		Glassine-laminated paper	24	8	43.8	0.1
		Aluminum foil	24	9	75.0	1.0
		Glass	24	8	50.0	0.0
	−20	Butcherwrap	16	8	25.0	2.0
		Butcherwrap	24	8	50.0	0.0
		Glassine-laminated paper	24	8	43.8	0.1
		Aluminum foil	24	9	68.8	0.4
		Glass	24	8	62.5	0.5
	−30	Butcherwrap	16	8	37.5	0.5
		Butcherwrap	24	8	50.0	0.0
		Glassine-laminated paper	24	8	50.0	0.0
		Aluminum foil	24	9	68.8	0.4
		Glass	24	8	56.2	0.1
	−40	Butcherwrap	24	8	50.0	0.0
		Glassine-laminated paper	24	8	37.5	0.5
		Aluminum foil	24	8	68.8	0.5
		Glass	24	8	37.5	0.5

[1] Chi-Square below 3.841 is not significant; 6.635 is usually considered highly significant for one degree of freedom as here.
[2] Significant.
[3] Highly significant.

ethylene-coated paper and those in butcherwrap were inconsistent and insignificant. Average scores for these samples in their various wrapping materials were also calculated and are presented in Table 7.

TABLE 7

Flavor scores of frozen meats in various wrappings
(Based on descriptive adjectives with paired-eating methods)

Kind of meat	Wrappings of samples compared in pairs	Storage period	Average score at various temperatures ° F.			
			0	—20	—30	—40
Bacon	Polyethylene-coated paper	11 weeks	3.38	3.50	4.38	.....
	Butcherwrap	11 weeks	3.12	3.12	3.75	.....
	Polyethylene-coated paper	23 weeks	3.12	4.00	3.88	.....
	Butcherwrap	23 weeks	2.62	3.50	4.00	.....
	Polyethylene-coated paper	39 weeks	1.87	3.12	4.12	3.88
	Butcherwrap	39 weeks	1.75	2.75	3.88	3.50
	Polyethylene-coated paper	50 weeks	1.50	3.25	2.38	3.25
	Glassine-laminated paper	50 weeks	2.75	3.00	3.25	3.88
	Polyethylene-coated paper	50 weeks	1.75	2.50	2.38	3.50
	Aluminum foil	50 weeks	3.38	2.88	3.62	3.38
Sausage	Polyethylene-coated paper	10 months	2.88	2.75	3.25	.....
	Butcherwrap	10 months	2.88	2.75	3.25	.....
	Polyethylene-coated paper	17 months	2.75	3.12	3.88	.....
	Butcherwrap	17 months	2.88	2.62	3.62	.....
	Polyethylene-coated paper	23 months	3.62	3.00	3.75	4.25
	Butcherwrap	23 months	1.75	3.50	3.50	3.88
	Polyethylene-coated paper	23 months	3.12	3.75	4.38	4.25
	Glassine-laminated paper	23 months	3.38	3.88	4.25	3.88
	Polyethylene-coated paper	23 months	1.88	3.50	3.50	4.25
	Aluminum foil	23 months	3.75	3.88	3.38	4.25
	Polyethylene-coated paper	23 months	2.38	2.62	3.50	4.00
	Glass	23 months	3.12	3.38	3.12	3.88
Hamburg	Polyethylene-coated paper	16 months	3.50	3.88	3.75	.....
	Butcherwrap	16 months	3.12	3.00	3.62	.....
	Polyethylene-coated paper	24 months	3.38	3.38	3.62	4.00
	Butcherwrap	24 months	2.50	3.38	4.00	3.50
	Polyethylene-coated paper	24 months	3.38	3.50	3.75	4.12
	Glassine-laminated paper	24 months	3.25	3.00	3.88	3.75
	Polyethylene-coated paper	24 months	3.00	3.11	3.78	3.62
	Aluminum foil	24 months	3.11	3.11	4.00	4.12
	Polyethylene-coated paper	24 months	3.00	2.50	3.50	3.75
	Glass	24 months	3.00	2.88	3.88	3.62

SUMMARY

The keeping quality of hamburg, bacon, and sausage stored at the usual home-freezer temperature of 0° F. was compared with corresponding samples stored at lower temperatures (—20° F., —30° F. and —40° F.) as to their peroxide development and flavor. Moisture loss from hamburg stored at these temperatures was noted.

By lowering the freezer storage temperature, the development of rancidity was found to be retarded and the lower the temperature the greater was the retardation effect.

Several kinds of wrapping materials were used for each kind of meat at each storage temperature. Aluminum foil and glassine-laminated paper both retarded the development of rancidity of each kind of meat at each storage temperature, when compared with corresponding samples wrapped in polyethylene-coated paper and when compared with butcherwrap of good grade. Little difference was found in the development of rancidity between meats in the two latter wrapping materials. Results of organoleptic tests agreed, in general, with the results of peroxide determinations.

Moisture loss from hamburg was insignificant at any storage temperature when aluminum foil, glassine-laminated paper or polyethylene-coated paper were used. The samples in butcherwrap showed rapid loss of moisture when stored at 0° F., but decided protection was noted when the storage temperature for samples in this type of wrapping was —20° F. or lower.

Acknowledgment

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Odor Studies With Cannery Wastes[a,b]

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An objective method for evaluating the odor of decomposing cannery wastes is described. Methods of controlling odors are evaluated. Aeration of tomato waste was demonstrated in this experiment to be more effective as an odor control method than were the chemical preparations tested.

Waste disposal is an important adjunct of the tomato processing industry. Approximately 250 million gallons of liquid waste results from the production of some 10 to 12 million cases of tomatoes and tomato products in Indiana each year.

This waste contains on the average 1900 p.p.m. of total solids, 500 p.p.m. suspended solids, 100 ml. per liter sediment solids, a five-day Biochemical Oxygen Demand (B.O.D.) of 1100 p.p.m., and has an average pH of 4.7 (see Table 1).

TABLE 1
The composition of tomato cannery waste

	5-day B.O.D. p.p.m.	pH	Solids		
			Total p.p.m.	Suspended p.p.m.	Sediment cc./liter
Eldridge *(4)*	2900	.....	.....	934	.....
Fenelon *(5)*	1150	4.9	2500	450	100
Sanborne *(16)*	1000-1400	4.6	.....	.....	.....
Kemberly *(10)*	615-1336	6.2[1]	.....	423-1000	.....
1926	850 average			641 average	
Kemberly *(10)*	615-1336	4.8	.....	423-1000	.....
1927	850 average			641 average	
Hert *(7)*	550	.....	1350	210-560	.....
				292 average	
Canham and	244-809	.....	1121	210-560	.....
Bloodgood *(1)*	538 average			292 average	
Average	1146	5.1	1905	576	100

[1] Lye peeling of the tomatoes caused this abnormally high pH.

The storage of cannery wastes in lagoons for stabilization is the widely employed method of disposal in Indiana. The storage of such waste generally results in decomposition and subsequent release of obnoxious odors.

Many other methods of waste disposal, such as biological filtration *(16, 2)*, anaerobic digestion *(2)*, furrow irrigation of farm land, chemical precipitation *(4)*, utilization of local community sewage disposal facilities *(15)*, manufacture of livestock feed *(3)*, and spray irrigation *(17)* are not generally applicable at present to the waste disposal problem of the average Indiana canner.

In a survey by the authors, of 38 canners who utilized lagoons in 1952, 10 used no odor controlling or masking substance, 11 used sodium nitrate, 10 used an ortho-di-chloro benzene compound and two used an essential oil preparation. Nine of the 11 reported that satisfactory odor control resulted from the use of sodium nitrate, but two reported that they were not satisfied with the results. Seven of the 10 canners who used the ortho-di-chloro benzene compound in 1952 reported that odor control was satisfactory with no complaints received from residents of nearby areas or from the plant personnel. One of the two users of the essential oil compound was satisfied with the results obtained, and the other stated that he had not used it long enough to form an opinion. Although not a public health hazard, odors from cannery lagoons are very undesirable and often cause adverse public reactions. Considerable interest has developed relative to the odor control problem.

Preliminary studies, using organoleptic odor analyses, revealed the problem of odor evaluation relative to comparing replicated treatments due to the variability in the human element. The primary purpose of the present investigation was to develop an objective method for evaluating the odor of decomposing cannery wastes. Some methods of controlling odors were also evaluated.

METHODS OF MEASURING ODOR

Niccolini *(18)* wrote that a substance to be odoriferous must be volatile, oxidizable, and soluble in the nasal mucosa.

The Stinkometer. Lang and co-workers *(11)* devised an apparatus called the Stinkometer for measuring odor as indicated by volatile reducing gases. This apparatus consisted of a gas-washing train, an aeration flask, 2 reaction flasks, a dehydrating solution, a flowmeter and a vacuum pump. These pieces of equipment were connected in series so that the air upon entering the system was cleaned, passed through the sample being analyzed, then through the reaction flasks, and out through the vacuum pump. By a sweeping action the volatile reducing gases contained in the sample were carried over into the 2 reaction flasks where potassium permanganate was reduced. They reported that deterioration of food material was caused by different types of reactions all of which were detected by the Stinkometer, because the end products were always volatile reducing substances.

O'Grady *(13)* found that the Stinkometer method gave good agreement on duplicate samples, using coffee, swordfish, and ground beef. The results were reproducible within ± 2.0 microequivalents of reduction. Since this method of analysis detected all volatile reducing substances regardless of source, it was reported to be superior to methods for detecting only specific substances or related substances such as skatols, indols, hydrogen sulphide, volatile nitrogenous bases, and volatile acids.

Panel evaluations and threshold odor number. In discussing evaluation of odor intensity by panels, Girardot *(6)* pointed out that motivation was a very important consideration in selecting panel members. This factor was compensated for by using only members who were interested in the problem. Various precautions are discussed in the Standard Methods for the Examination of Water and Sewage *(20)*.

Other Studies

The odor evolved from a lagoon has been found to be dependent upon the amount of dissolved oxygen in the water, the bacterial activity, and the concentration of decomposable organic matter present.

Biological oxygen demand. The Biological Oxygen Demand *(19)* determination is the standard method for estimating the strength of industrial wastes. This test, frequently referred to as B.O.D., is the oxygen required in p.p.m. during the complete stabilization of decomposable organic matter.

[a] Journal Paper No. 775. Purdue University, Agricultural Experiment Station, Lafayette, Indiana.

[b] Address presented at the 13th Annual Meeting, Institute of Food Technologists, Boston, Massachusetts, June 23, 1953.

Bacteriological study. As has been reported by Heukelekian *(8)*, Sanborne *(18)*, Lightfoot *(12)*, and Ruchoft *(14)*, no foul odor developed when decomposition of waste occurred under aerobic conditions. Bacterial activity therefore is an important factor in studying odors from wastes.

EXPERIMENTAL PROCEDURE

Laboratory studies. Samples of waste containing approximately 1000 p.p.m. B.O.D. were prepared by mixing canned tomatoes in a Waring blender and diluting with water to the desired level. Nine liter samples of the waste were placed in 10 l. glazed jars and inoculated with 100 g. decomposed tomatoes and soil from a tomato cannery lagoon which had received waste in 1951. The samples were then held at room temperature and treated with the materials listed below at the rate of 70 p.p.m. Sodium nitrate was applied at the rate of 70 p.p.m. so that the results of all the treatments could be compared directly. The generally accepted rate of treatment for sodium nitrate has been 20% of the B.O.D.

MATERIALS

An ortho-di-chloro benzene preparation (O.D.C.B.).
An aromatic, essential oil compound (A.E.O.).
Sodium nitrate.
Control (no treatment).
Air at the rate of one l. every 2 minutes.

A known amount of air was forced through the solutions as calibrated by use of a flowmeter. A constant air pressure was maintained on a capillary tube by varying the depth of the air by-pass outlet in a column of water. With the pressure held constant, the rate of flow was determined by water displacement, and adjusted to deliver one l. of air every 2 minutes.

From June, 1952, to December, 1952, the materials listed above were evaluated as odor controlling compounds by use of Stinkometer readings, threshold odor measurements, panels evaluations, and bacteriological examinations. Laboratory studies were repeated a minimum of 8 times, and typical results are reported herein.

Stinkometer evaluation. A 5-ml. sample of waste was placed in the aeration flask *(11)* and treated for 2.5 hours. The microequivalents of reducing gases present were then calculated. Blank controls were carried.

Threshold odor number. Various quantities of the waste samples were placed in flasks, diluted with odor-free water *(20)*, until the smallest amount still having a perceptible odor when diluted to 200 ml. had been determined. The threshold odor number was found by dividing 200 by the ml. of waste in the highest dilution still having a perceptible odor. Intermediate dilutions were prepared between the sample having odor and the one not having odor. Results recorded by the panel were positive or negative relative to the detection of odor.

Panel evaluations. Samples to be evaluated by the members of the panel were placed in one-pint glass bottles which had been painted with a black odorless paint in order to mask the differences in color. The sample bottles were marked with a code number which did not identify various treatments for the observers.

Participants in the evaluations were members of the staff and students. Panel members were informed as to the purpose of the tests and were then handed a score sheet with written instructions which stated "rank in order of decreasing obnoxious odor intensity." Distilled water blanks were used, and more than 3 samples were never evaluated at one time.

In order to evaluate the results of the panel data 4 points were assigned to a treatment each time it was selected as having the most obnoxious odor, 3 points to the one having the next most obnoxious odor, etc. The sum of all the evaluations was then divided by the number of evaluations and the resulting value was assigned to each treatment.

Bacteriological studies. Aerobic and anaerobic plate counts were made on treated and control waste materials *(20)*.

Lagoon studies. It was difficult to compare data collected from the various cannery lagoons due to the great differences in the location, construction, and maintenance of the ponds.

No control lagoon was used because it was not possible to find an untreated one which was comparable to the treated ponds. Although every effort was made to find lagoons as nearly alike as possible, it must be pointed out that the ones in which both the ortho-di-chloro benzene and the essential oil compounds were being used were maintained in better condition than the one in which sodium nitrate was used. The exact depth of the lagoons was not known, but visual estimation indicated them to be equal prior to their employment for this study. Lagoon dimensions and factory production were comparable.

From August 6, 1952, to November 15, 1952, samples were collected weekly from canning plant waste disposal lagoons and analyzed. The lagoons were treated with the following materials according to manufacturer recommendations:

1. Ortho-di-chloro benzene compound, solids not removed.[c]
2. Ortho-di-chloro benzene compound, solids removed.[d]
3. Aromatic essential oil preparation.[e]
4. Sodium nitrate.[f]

RESULTS AND DISCUSSION

The Stinkometer

The length of time necessary for the air passing through the Stinkometer to remove the volatile reducing gases from a 5-ml. aliquot was determined. It was found that after 2 hours the increase in volatile reducing gases was less than the experimental error (Figure 1). However, subsequent samples were aerated for 2½ hours in order to allow a factor of safety.

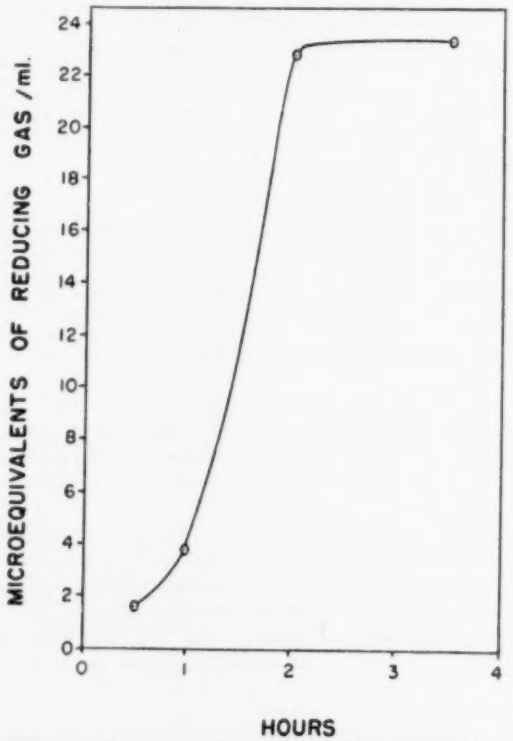

Figure 1. Time required to remove the volatile reducing gases from five milliliters of tomato waste by use of the Stinkometer.

Preliminary results of the study indicated that Stinkometer values were reproducible to within ±2.0 microequivalents of reducing gases per ml. of tomato waste.

[c] Plumtree, Indiana. [d] Elwood, Indiana. [e] Dunreith, Indiana. [f] Kempton, Indiana.

Correlation of Objective and Organoleptical Methods of Measuring Odor

Stinkometer vs. threshold odor number. Statistical analysis of the data indicated that the correlation coefficient (r) for the Stinkometer data versus the threshold odor number was 0.65. Since a coefficient of 0.62 indicated significance at the 1% level, there was evidence that the Stinkometer and threshold odor data were related (Figure 2).

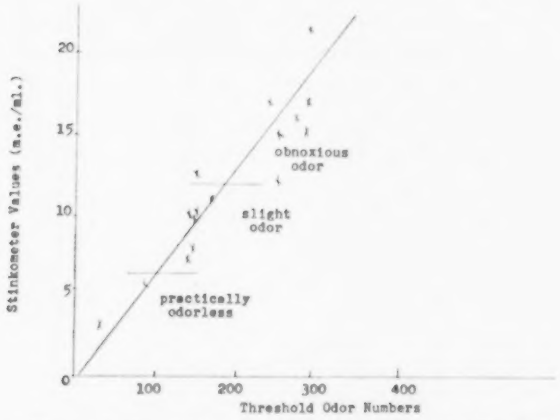

Figure 2. Correlation of Stinkometer values with threshold odor numbers of laboratory tomato waste samples.

Stinkometer vs. panel. The correlation coefficient for the Stinkometer versus the panel data was found to be 0.72. Because a coefficient of 0.66 indicated significance at the 5% level, there was evidence that the Stinkometer and panel data also were related.

Figure 2 indicates that a Stinkometer value of 12 and a threshold odor number of 180 were the levels above which the odor became objectionable, while below a Stinkometer value of six and a threshold odor number of 100, the waste was practically odorless. Between Stinkometer values of 6 and 12 there was a slightly objectionable odor.

Panel Data

Lagoon. Statistical analysis of the panel data indicated that the Lsd. (1%) between treatments in the lagoon study was 0.60 of a panel unit. Assuming that sodium nitrate is a generally accepted standard treatment, data (Table 2) showed that the difference between sodium nitrate and O.D.C.B. (1.67) was significant and indicated that the O.D.C.B. compound was more effective than the sodium nitrate treatments. Since there was a difference of only 0.16 between the sodium nitrate and the A.E.O. treatment, the difference was not significant in the field study.

TABLE 2

The Lsd., 1% of data involving four panels (79 participants). Thirty-one panel members evaluated waste from the field and 48 participants rated waste from the laboratory

	Control	Sodium Nitrate	A.E.O.	O.D.C.B.	Aeration
Panel Rating Lagoon Data Lsd., 1% 0.60	.....	3.21	3.05	1.54	.....
Panel Rating Lab. Data Lsd., 1% 0.46	3.34	3.06	1.91	1.69	00.0

Laboratory. Statistical analysis of laboratory panel data indicated (Table 2) that the Lsd. (1%) was 0.46 of a panel unit. There was no significant difference between sodium nitrate, under the conditions of the experiments, and the control (0.28) or the A.E.O. and the O.D.C.B. compound (0.22). However, the data indicated that both O.D.C.B. and A.E.O. compounds were better than the control in the laboratory tests.

A difference of 3.34 panel units which was highly significant was indicated between the aerated and control samples of tomato waste.

Stinkometer Data

Lagoon. The Stinkometer readings remained below 12 during the first 3 weeks of the canning season except for waste from the lagoon treated with the A.E.O. preparation (Figure 4). The Stinkometer values for waste samples from the A.E.O. treated lagoon increased from 6 to 39 between the 6th and 18th day of the experiment. The microequivalents of reducing gases per ml. of waste treated with sodium nitrate increased from 5 to 36 between the 21st to the 30th day. Tomato waste with the solid portion removed prior to lagooning and treated with the O.D.C.B. compound gave Stinkometer values of 13 on the 21st day and 33 on the 39th day. In all cases the rapid increase in Stinkometer values coincided with an increase in raw product intake.

The only tomato waste evaluated in this study which did not develop an obnoxious odor came from a lagoon receiving unscreened tomato waste treated with the O.D.C.B. compound. The lagoon was in good condition to begin with, although the practice of lagooning unscreened waste is contrary to present thought.

Laboratory. The amount of volatile reducing gases (Figure 3) evolved from untreated tomato waste, as measured by the Stinkometer, increased from 15 microequivalents per ml., on the day after the fermentation started, to 22 by the 5th day. After the 5th day, the concentration of volatile reducing gases decreased until a value of 3 was obtained on the 8th day.

The Stinkometer value for tomato waste aerated at the rate of one l. of air every 2 minutes per 9 l. of solution increased to a maximum of 17 microequivalents of reducing gases per ml. on the 3rd day; however, by the 4th day a reading of zero was obtained, and no further evolution of obnoxious odor was detected.

Foul odors failed to develop in tomato waste treated with sodium nitrate as shown by the decrease in the Stinkometer values of from 15 to 8 for 4 days after treatment. However, the amount of sodium nitrate added was apparently not sufficient as indicated by the increase in volatile reducing gases from the 4th to the 6th day of the fermentation (Figure 3).

The Stinkometer values for tomato waste treated with O.D.C.B. were similar to those for the sodium nitrate treatment.

Stinkometer values for tomato waste treated with the A.E.O. preparation fluctuated between 11 and 15 throughout the experiments.

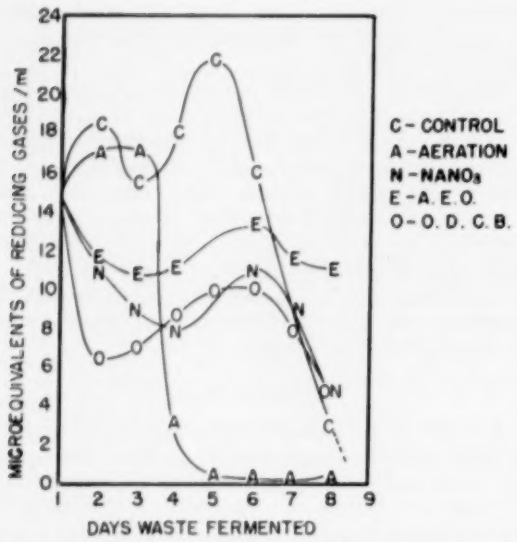

Figure 3. The microequivalents of reducing gases from laboratory samples of tomato waste treated as indicated.

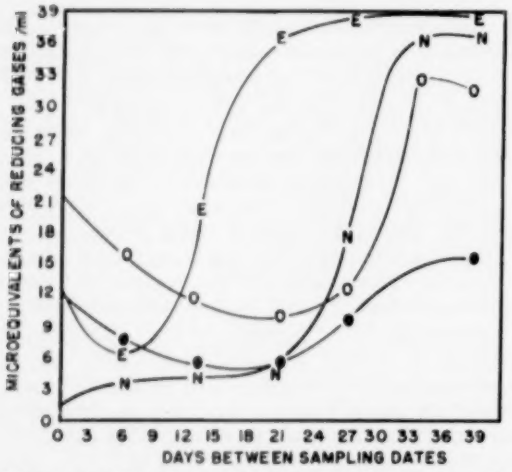

Figure 4. The microequivalents of reducing gases from tomato canning plant's lagoons treated as indicated.

●—O. D. C. B. Solids not removed N—Sodium nitrate
O—O. D. C. B. Solids removed E—A. E. O.

Bacteriological Data

Aerobic organisms. As shown by Figure 5 there was little difference in the laboratory studies between the number of aerobic organisms present in tomato waste treated with sodium nitrate or O.D.C.B. during the first 9 days after inoculation; however, there were more aerobes present in the nitrate treated waste from the 9th to the 19th day. Both treatments maintained the aerobes in higher numbers than were found in the untreated solution.

Tomato waste treated with the A.E.O. compound contained fewer aerobic organisms than the control solution under the conditions of this study. As anticipated, the aerated waste contained more aerobic organisms throughout the experiments than any of the other treatments.

Anaerobic organisms. As indicated by Figure 6 untreated tomato waste contained about 13 million anaerobic organisms per ml. 3 to 4 days after inoculation. The solutions treated with O.D.C.B. and sodium nitrate contained a maximum of about 11 million per ml.

The aerated waste contained less than one million anaerobes per ml. throughout the experiments.

The influence of the A.E.O. preparation was demonstrated by lower aerobic and anaerobic plate counts than those obtained from untreated samples.

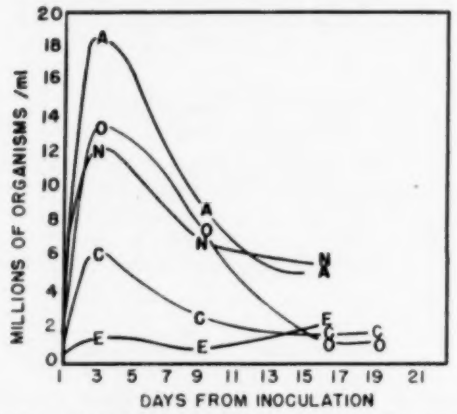

Figure 5. Aerobic plate counts on tomato waste treated as indicated in the laboratory.

C—Control N—$NaNO_3$ O—O. D. C. B.
A—Aeration E—A. E. O.

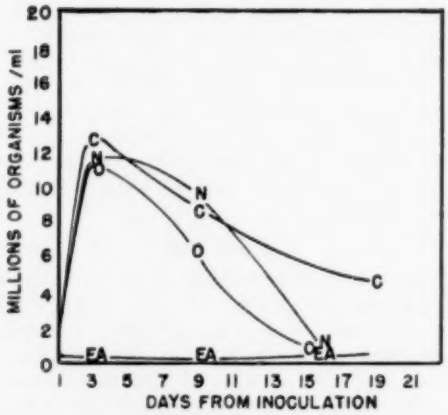

Figure 6. Anaerobic plate counts on tomato waste treated as indicated in the laboratory.

C—Control N—$NaNO_3$ O—O. D. C. B.
A—Aeration E—A. E. O.

Hydrogen Ion Concentration

Laboratory. Since it has been shown *(15)* that a pH of near neutral favors decomposition of tomato waste without foul odor production, the pH was measured.

A temporary increase in the pH of tomato waste treated with sodium nitrate from 4.7 to 6.0 during the first 3 days of the fermentation was followed by a decrease to pH 4.7 by the 5th day. From that time to the end of the laboratory experiment there was no apparent

difference between the nitrate treatment and the control (Figure 7).

The pH of the aerated waste increased from 4.7 to near neutrality (7.4) by the 5th day of the fermentation

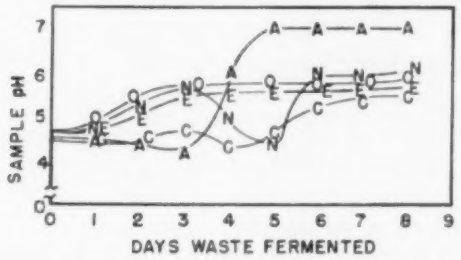

Figure 7. The pH of tomato waste as indicated in the laboratory.

C—Control	N—$NaNO_3$	O—O. D. C. B.
A—Aeration	E—A. E. O.	

and was maintained at that favorable level throughout the study.

The solutions treated with the O.D.C.B. and the A.E.O compounds had an initial pH value of 4.7. As indicated by Figure 7, the pH increased from 4.7 to 5.8 on the 2nd day of the experiment, and little deviation from that value was observed throughout the remainder of the experiment.

Lagoon. As shown by Figure 8 the pH of tomato waste from the 4 lagoons fluctuated between 4.5 and 5.0

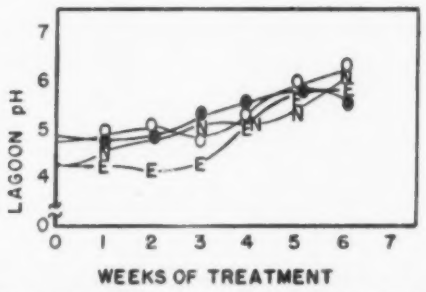

Figure 8. The pH of tomato waste in canning plant lagoons, treated as indicated (1952).

●—O. D. C. B. Solids not removed	N—Sodium nitrate
O—O. D. C. B. Soids removed	E—A. E. O.

at the time the first samples were collected. Throughout the period of testing, the pH of the waste materials from the lagoons treated with O.D.C.B. and sodium nitrate increased gradually until from 6.0 to 6.2 was reached. However, the lagoon which had been treated with the essential oil compound had a low pH of 4.3 to 4.5 throughout the first 4 weeks before an increase was observed. The pH did not reach a value of 6.0 during the season.

CONCLUSIONS

Stinkometer evaluations of the odors from decomposing tomato wastes were found to be significantly correlated with threshold odor numbers and panel odor evaluations.

Tomato wastes from lagoons containing more than 6 microequivalents of reducing gases were rated as having a slight odor, and wastes containing more than 12 microequivalents were rated as obnoxious.

The Stinkometer appears to be a useful objective measuring device for such odors, and may find application as an indicator of the condition of a lagoon prior to its becoming a nuisance, allowing time to apply remedial action.

Aeration of tomato waste stimulated aerobic bacterial growth, and was found to be more effective than sodium nitrate, ortho-di-chloro benzene compounds, or aromatic essential oil preparations in controlling odor in these studies, as demonstrated by Stinkometer evaluations, panel ratings, and threshold odor numbers.

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Studies in Canning Processes. I. Effect of Headspace on Heat Penetration in Products Heating by Conduction

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A method is given for determining the rate of heat transfer through the headspace of a can of solid food. Values of apparent heat transfer coefficients obtained for cans processed at 240° F. were between 6 and 10.5 BTU/(ft.)²(hr.)(°F.). Important consequences of this low rate of heat transfer are: (a) the slowest heating point is raised above the centre of the pack, (b) lethal values calculated from known or assumed thermal properties of the pack are considerably lower than when headspace effects are ignored, (c) no allowance for headspace effects is necessary when evaluating processes by measurement of temperatures but they must be taken into account when estimating equivalent processes for any cans from experimental measurements made with cans of a different shape, (d) there is little variation in F values between the centre of the pack and the slowest heating point.

If a product completely fills a can and has good contact with the end of the can, the rate of heat transfer to the top of the product is very high and for all practical purposes may be regarded as infinite. In normal canning practice, however, the cans are not completely filled and the rate at which heat passes through the headspace need not necessarily be large. No work appears to have been published on the rate of heat transfer through the headspace, or on the effect of the headspace on the canning process.

An account is here given of measurements made to determine the rate at which heat passes through the headspace. Using the results of these measurements, the effects of the headspace on the lethal value of a particular heating process are discussed.

The discussion is confined to the effects of the headspace on the heating of solid and highly viscous foods in which heat is transferred almost entirely by conduction. It is not intended to apply to liquid foods in which convection is the main mechanism of heat transfer.

EQUATIONS FOR THE TEMPERATURE IN A CAN WITH A HEADSPACE

Assuming no azimuthal variation, the differential equation in cylindrical co-ordinates which the temperature v at any point in the can must satisfy is:

$$\frac{\partial^2 v}{\partial r^2}+\frac{1}{r}\frac{\partial v}{\partial r}+\frac{\partial^2 v}{\partial x^2}=\frac{1}{a}\frac{\partial v}{\partial t} \quad , \qquad (1)$$

a being the thermal diffusivity of the product. A point in the can is specified by the distance x from the base of the can and the distance r from its axis.

To simplify the calculations a temperature scale was chosen in which the retort temperature was zero and the magnitude of the difference between the initial temperature of the product and the retort temperature was one unit; the initial temperature of the product on this scale was therefore —1. The following assumptions were then made:

a. That the rate of heat transfer is infinite through the sides and base where the product is in contact with the can.

b. That the rate of heat transfer to the top of the product is finite.

c. That the initial temperature of the product is uniform.

The boundary conditions that v must then satisfy are:

$$\begin{aligned} &\text{at } t = 0, && v = -1; \\ &\text{for } t > 0, && v \text{ is finite at } r = 0, && 0 \leqslant x \leqslant l, \\ & && v = 0, r = a, && 0 \leqslant x \leqslant l, \\ & && v = 0, x = 0, && 0 \leqslant r \leqslant a, \\ & && \frac{\partial v}{\partial x} = -h\,v, x = l, && 0 \leqslant r \leqslant a, \end{aligned} \qquad (2)$$

where a = radius of the product

l = height of the product.

The last boundary condition is obtained in the following way. Let H be the (finite) rate of heat transfer through the headspace and k the conductivity of the product. If A is the area of the top surface of the product, by Newton's law the heat flux through the headspace (from the can end at temperature zero to the product at temperature v) is H A v. This is equal to the heat conducted away by the product, namely— $k A \frac{\partial v}{\partial x}$. Thus at $x = l$,

$$\frac{\partial v}{\partial x} = -h\,v,$$

where

$$h = \frac{H}{k}. \qquad (3)$$

The solution of equations (1) and (2) may be expressed as the product of the solutions for (i) an infinite cylinder and (ii) an infinite slab. The cylindrical solution must satisfy:

$$\frac{\partial^2 R}{\partial r^2} + \frac{1}{r}\frac{\partial R}{\partial r} = \frac{1}{a}\frac{\partial R}{\partial t}, \qquad (4)$$

with the boundary conditions:

$$\begin{aligned} &\text{at } t = O, && R = 1, \\ &\text{for } t > O, && R \text{ finite at } r = O, \\ & && R = O \text{ at } r = a. \end{aligned} \qquad (5)$$

The solution [1] of these equations is:

$$R = -2\sum_{n=1}^{\infty} \frac{J_o\left(\gamma_n \frac{r}{a}\right)}{\gamma_n J_1(\gamma_n)} e^{-a\gamma_n^2 t/a^2}, \qquad (6)$$

where γ_n are the positive zeros of

$$J_o(\gamma) = O. \qquad (7)$$

The solution X for the infinite slab must satisfy:

$$\frac{\partial^2 X}{\partial x^2} = \frac{1}{a}\frac{\partial X}{\partial t}, \qquad (8)$$

with the boundary conditions:

$$\begin{aligned} &\text{at } t = O, && X = +1; \\ &\text{for } t > O \quad X = O, && \text{at } x = O, \\ & && \frac{\partial X}{\partial x} = -h\,X, \text{ at } x = l. \end{aligned} \qquad (9)$$

The solution for X satisfying (8) and (9) is:

$$X = 2\sum_{m=1}^{\infty} \frac{(1-\cos\beta_m)\sin\left(\beta_m x/l\right)}{(\beta_m - \sin\beta_m \cos\beta_m)} e^{-a\beta_m^2 t/l^2}, \qquad (10)$$

where β_m are the positive roots of:

$$\beta \cot\beta + hl = O. \qquad (11)$$

The product solution for v is then:

$$v = RX, \qquad (12)$$

where R is expression (6) and X is expression (10).

By changing to a scale of temperature in which the initial temperature of the product is zero and the retort temperature is V_1 the formula for v becomes:

$$v = V_1\left\{1 - 4\sum_{n=1}^{\infty} \frac{J_o\left(r\frac{\gamma_n}{a}\right)}{\gamma_n J_1(\gamma_n)} e^{-a\gamma_n^2 t/a^2} \cdot \sum_{m=1}^{\infty} \frac{(1-\cos\beta_m)\sin\left(\beta_m x/l\right)}{(\beta_m - \sin\beta_m\cos\beta_m)} e^{-a\beta_m^2 t/l^2}\right\} \qquad (13)$$

where γ_n are the positive zeros of (7) and β_m the positive roots of (11).

METHOD OF DETERMINING THE HEAT TRANSFER COEFFICIENT H AND DIFFUSIVITY a

In order to determine H and a experimentally the temperature histories at two points in the product were required. Measurements of the temperature during a heating process were made at the centre of the product and the centre of its top surface, these being the most convenient points.

When a sufficiently long time has elapsed from the beginning of the heating process, all but the first terms in the series of equation (13) are negligible so that the temperature v_c at the centre where $r = O$ and $x = l_2$, has the value:

$$v_c = V_1\left\{1 - \frac{4(1-\cos\beta_1)\sin(\beta_1/2)}{\gamma_1 J_1(\gamma_1)(\beta_1 - \sin\beta_1\cos\beta_1)} e^{-a\left(\gamma_1^2/a^2 + \beta_1^2/l^2\right)t}\right\} \qquad (14)$$

and the temperature v_t at the centre of the top surface, where $r = O$ and $x = l$, has the value:

$$v_t = V_1\left\{1 - \frac{4(1-\cos\beta_1)\sin\beta_1}{\gamma_1 J_1(\gamma_1)(\beta_1 - \sin\beta_1\cos\beta_1)} e^{-a\left(\gamma_1^2/a^2 + \beta_1^2/l^2\right)t}\right\} \qquad (15)$$

γ_1 being the first positive zero of equation (7) and β_1, the first positive root of equation (11).

From equations (14) and (15) the asymptotic values of ln $(V_1 - v_c)$ and ln $(V_1 - v_t)$ for large values of the time are:

$$\ln(V_1 - v_c) = \ln\left\{\frac{4V_1(1-\cos\beta_1)\sin(\beta_1/2)}{\gamma_1 J_1(\gamma_1)(\beta_1 - \sin\beta_1\cos\beta_1)}\right\} - a\left(\frac{\gamma_1^2}{a^2} + \frac{\beta_1^2}{l^2}\right)t \qquad (16)$$

and

$$\ln(V_1 - v_t) = \ln\left\{\frac{4V_1(1-\cos\beta_1)\sin\beta_1}{\gamma_1 J_1(\gamma_1)(\beta_1 - \sin\beta_1\cos\beta_1)}\right\} - a\left(\frac{\gamma_1^2}{a^2} + \frac{\beta_1^2}{l^2}\right)t \qquad (17)$$

respectively.

These expressions, when plotted against the time t represent two parallel straight lines whose common slope is given by:

$$\text{slope} = -a\left(\frac{\gamma_1^2}{a^2} + \frac{\beta_1^2}{l^2}\right). \qquad (18)$$

The difference between their intercepts on the ln $(V_1 - v)$ axis where $t = O$, is given by

$$[\ln(V_1 - v_c) - \ln(V_1 - v_t)]_{t=O} = \ln\frac{1}{2\cos(\beta_1/2)} \qquad (19)$$

Thus by plotting the experimental values of ln $(V_1 - v_c)$ and ln $(V_1 - v_t)$ against the time, the difference between their intercepts on the ln $(V_1 - v)$ axis gives β_1 from equation (19) and hence hl from equation (11); h is then obtained by using a measured value of l.

Also, by measuring the slope of these experimental curves, measuring the radius "a" of the packs and using the known values of γ_1 (= 2.4048), β_1 and l the thermal diffusivity a of the product is obtained from equation (18).

Multiplying a by measured values of the density and specific heat of the product gives the conductivity k. Thus knowing h and k the heat transfer coefficient H is obtained from equation (3).

EXPERIMENTAL PROCEDURE

Difficulty was experienced in finding a suitable product for obtaining reliable experimental data. The first product tested, a meat pack, was not sufficiently homogeneous. In addition,

free liquid appeared towards the end of the heat treatment resulting in broken heating curves.

Measurements made on pumpkin were more consistent but shrinkage during processing caused cracks to develop on the top surface, making the results inaccurate.

Dried navy beans milled to a coarse powder and mixed with approximately the same volume of water were also tried. Initially the mixture was too dry, but on adding about 15% by weight of a bentonite suspension (30% bentonite, 70% water with a trace of magnesium oxide) the product behaved satisfactorily. It was necessary however to take the additional precaution of giving the product a 100 min. cook at 240° F. some time before taking readings.

Although only the results taken with the bean-bentonite mixture are quoted below, similar trends were observed with both the meat pack and pumpkin.

Three different can sizes were used, namely No. 2½ can (401 x 411), No. 1 tall (301 x 411) and 1 lb. squat (401 x 211). The headspace in the first two can sizes was 1 cm., but a little less in the 1 lb. squat. The thermocouples of 31 B & S (approximately 34 S.W.G.) enamelled copper and 28 S.W.G. enamelled constantan were led through the sides of the cans. The couple measuring the temperature v_c at the middle of the top of the product was soldered to a $\frac{5}{8}$" diameter 24 gauge copper disc to keep it in position during processing. To eliminate the possible occurrence of stray chemical e.m.f.'s all couples were lacquered.

Care was taken to ensure that, during processing, each can remained in an upright position.

The specific heat of the product was measured by the method of mixtures taking the usual precautions.

RESULTS AND THEIR INTERPRETATION

By the methods already outlined, values of α, the thermal diffusivity of the product, and H, the heat transfer coefficient through the headspace, were obtained from the curves of $\ln (V_1 - V_c)$ and $\ln (V_1 - v_1)$ against the time t. The results given in Table 1 were obtained with the bean-bentonite mixture.

Cans A, B, E, F, H and I were prepared and processed at the same time. The heating curves for cans F and H were not entirely satisfactory, due probably to movement of the thermocouples during processing. This is reflected by the abnormal values for the thermal diffusivity for these two cans. The values found for the heat transfer coefficient H, however, were not very different from those found with the other cans. Cans C, D and G were processed with a different batch of the bean-bentonite mixture, as is again shown by the values obtained for α.

Table 1 shows values of H ranging from 6 to 10 B.T.U./(ft.)^2 (hr.) (° F.) [0.8 to 1.4 x 10^{-4} cals./(cm.)^2 (sec.) (° C.)]. These values are higher than would be expected if the heat were transferred by radiation and convection alone. These latter processes could account for only about 2.5 B.T.U./(ft.)^2 (hr.) (° F.) at the temperature of the retort, namely, 240° F. This means that an additional rate of heat transfer of between 4 and 8 B.T.U./(ft.)^2 (hr.) (° F.) must be accounted for by another mechanism.

The most likely explanation for this additional rate of heat transfer is that distillation occurs in the headspace. Water from the moist product evaporates in the headspace, particularly near the hot body of the can which is approximately at retort temperature, and condenses on the cooler parts of the top surface of the product. The whole of this effect is represented as an equivalent heat transfer coefficient between the top of the can and the top of the product.

This explanation was tested by examining the rate of heat transfer at a lower ambient temperature where a much lower rate of distillation and a smaller heat transfer coefficient would be expected. Measurements similar to those in the retort were made with the same product in cans of the same sizes when immersed in a well-stirred water-bath at 104° F. (40° C.). The rate of heat transfer from the water to the cans was determined by measuring the centre temperature of a brass cylinder of known thermal properties when immersed in the bath, the initial temperature of the cylinder being 32° F. The rate found was 400 B.T.U./(ft.)^2 (hr.) (° F.) which was regarded as infinite for subsequent calculations. This approximation introduced a possible error of less than 1%.

A set of readings taken with the bean-bentonite mixture in the water-bath is given in Table 2.

TABLE 1

Results of heat penetration measurements in retort [1]

Can type	Can	Initial temp. ° F.	Retort temp. ° F.	Product density grms./(cm.)^3	Specific heat of product cals./(grm.)(° C.)	α x 10^3 (cm.)^2/sec.	β_1	hl	h (cm.)$^{-1}$	k x 10^3 cals./(cm.)^2 (sec.)(° C./cm.)	H x 10^3 cals./(cm.)^2 (sec.)(° C.)	H B.T.U./(ft.)^2(hr.)(° F.)
No. 2½	A	75	240	1.08	0.90	1.73	2.72	6.08	0.566	1.68	0.95	7.0
	B	75	240	1.08	0.90	1.72	2.80	8.02	0.746	1.68	1.25	9.2
	C	83.5	241	1.05	0.86	1.89	2.74	6.34	0.590	1.71	1.01	7.4
	D	83.5	241	1.05	0.86	1.80	2.76	6.97	0.648	1.63	1.05	7.8
No. 1 tall	E	75	240	1.08	0.90	1.69	2.71	5.92	0.550	1.64	0.90	6.7
	F	75	240	1.08	0.90	1.94	2.81	8.13	0.754	1.89	1.42	10.5
	G	62.5	242	1.05	0.86	1.89	2.76	6.82	0.635	1.70	1.09	8.0
1 lb. squat	H	75	240	1.08	0.90	1.54	2.63	4.67	0.812	1.50	1.22	9.0
	I	75	240	1.08	0.90	1.70	2.44	2.90	0.505	1.66	0.84	6.2

[1] Metric units were used in the work but rates of heat transfer are generally quoted in the more familiar British units.

TABLE 2

Results of heat penetration measurements in well-stirred water-bath

Initial temperature 32° F. Bath temperature 104° F. (40° C.).

Density and specific heat of product 1.08 g./(cm.)^3 and 0.90 cals./(g.)(° C.) respectively.

Can type	Can	α x 10^3 (cm.)^2/sec.	β_1	hl	h (cm.)$^{-1}$	k x 10^3 cals./(cm.)^2 (sec.)(° C./cm.)	H x 10^3 cals./(cm.)^2 (sec.)(° C.)	H B.T.U./(ft.)^2 (hr.)(° F.)
No. 2½	J	1.37	2.33	2.23	0.208	1.33	0.28	2.0
No. 1 tall	K	1.41	2.51	3.39	0.315	1.37	0.43	3.2
	L	1.31	2.39	2.55	0.237	1.27	0.30	2.2
1 lb. squat	M	1.33	2.09	1.21	0.210	1.29	0.27	2.0
	N	1.28	2.29	1.99	0.345	1.24	0.43	3.2

For all cans the value of the heat transfer coefficient H in the water-bath was near the value expected from radiative and convective heating, together with possibly a small amount of distillation.

It is important to note that the rate at which radiative and convective heating increases with temperature is quite small. From about 2 B.T.U./(ft.)^2 (hr.) (° F.) at the temperature of the water-bath it increases to only 2.5 B.T.U./(ft.)^2 (hr.) (° F.) at the temperature of the retort *(2)*.

It should also be noted that the apparent thermal diffusivity α in the water bath [1.35×10^{-2} (cm.)^2/sec.] was much lower than in the retort[6] [1.70×10^{-2} (cm.)^2/sec.]. This increase of 26% was much higher than expected, since α for water, for example, in a similar range of temperature, changes only from 1.47×10^{-2} to 1.60×10^{-2} (cm.)^2/sec., an increase of 9%. Other samples of the bean-bentonite mixture gave changes of between 15% and 20% for α in the retort and water-bath.

The distillation process would itself tend to increase the measured value of α. In the formulae the rate of heat transfer is assumed to be uniform across the whole headspace whereas with distillation there is evaporation at the edge and condensation on the inner parts of the surface, this condensation being most rapid at the centre. Thus the rate of heat transfer to the top of the pack due to distillation alone is greatest at the centre and least at the outside. This would tend to make the value obtained for α larger than if the rate of heat transfer through the headspace was uniform.

Part of this increase in α for higher temperatures may also have been due to a small amount of convective heating being super-imposed on heating by conduction because, as the temperature of the pack approaches that of the retort, not only can the product give off a certain amount of free liquid but its viscosity will also decrease appreciably.

EFFECT OF FINITE RATE OF HEAT TRANSFER THROUGH THE HEADSPACE

In the past the rate of heat penetration into cans of food has generally been calculated on the assumption that the rate of heat transfer to all surfaces of the product was large enough to be regarded as infinite. The present work shows, however, that the rate of heat transfer through the headspace is only of the order of 6 to 10 B.T.U./(ft.)^2 (hr.) (° F.) [0.8×10^{-3} to 1.4×10^{-3} cals./(cm.)^2 (sec.) (° C.)].

Since this work was done Hurwicz and Tischer *(3)* have published experimental data on the rates of heating at a number of points in cans of beef. Their diagrams of isothermal lines in the beef seem to be asymmetrical about a plane through the middle of the can perpendicular to its axis. This asymmetry may be attributed to the thermal resistance of the headspace. Only approximate estimates of the rate of heat transfer through the headspace can be derived from the data given but calculations which we made gave values similar to those quoted in Table 1.

Since the heat transfer coefficient H through the headspace is finite, the slowest heating point of the product is not its centre but a point on its axis a short distance above the centre. In the extreme case when H is zero, the slowest heating point would be the centre of the top surface of the product.

The most important consequence of a finite value of H for the headspace is that the F value, calculated from the thermal properties of the pack, is lower for a particular length of heat treatment than the value calculated assuming an infinite H. It is important to note, however, that this finite H does not affect the lethal value based on experimental temperature measurements as such a determination is independent of the fact that heat penetrates the pack at a lower rate through the top than through the sides and base.

Calculations were made on a No. 2½ can (401 x 411) taking the height "*l*" of the product as 10.16 cms. and the radius "a" as 5 cms., the thermal diffusivity α as 0.090 (cms.)^2/min. The value for hl was taken as 7, corresponding to H = 7.6 B.T.U./(ft.)^2 (hr.) (° F.). This is a little less than the mean of the values of H given in Table 1 which is 8.0 B.T.U./(ft.)^2 (hr.) (° F.).

By differentiating the slab term in equation (13) with respect to x and finding the stationary point (only the first term in the series need be considered), the slowest heating point in the pack is found. This has a value of x given by:

$$x = \frac{\pi l}{2\beta_1} \qquad (23)$$

For the No. 2½ can the slowest heating point was found to be x = 5.68 cms., which is 0.60 cms. above the centre of the pack. To find the effect on the F value, calculations were made assuming the same physical conditions as in some of the calculations made by Hicks *(4)*. In Table 3 are given the F values found by Hicks, assuming H is infinite, when the centre of the pack is the slowest heating point, along with the corresponding F values at the centre and at the slowest heating point, assuming H = 7.6 B.T.U./(ft.)^2 (hr.) (° F.).

TABLE 3

F values for infinite and finite rate of heat transfer through the headspace

No. 2½ can (401 x 411). Initial temperature 180° F. (82.2° C.). Retort temperature 240° F. (115.6° C.). 100 minutes cook followed by cooling in water at 70° F. (21.1° C.).

z = 18° F.

Diffusivity α = 1.5 x 10^{-3} (cm.)^2/(sec.).

	H. Infinite	H. Finite (7.6 B.T.U./(ft.)^2 (hr.) (° F.)]	
	Hicks' values at centre	Centre	Slowest heating point
Heating phase	2.80	2.37	2.32
Cooling phase	2.44	2.21	2.29
Total F	5.24	4.58	4.61

Evidently, in the case of finite H, the slowest heating point is also the slowest cooling point so that the total F value at that point is slightly greater than that at the centre. The difference, however, is of the same order of magnitude as the error to be expected in the calculation, so that it may be concluded that the total F value is about the same at the centre and the slowest heating point and, in fact, at any intermediate point.

The finite rate of heat transfer through the headspace diminishes the calculated total F value appreciably, the values given in Table 3 being 12% below Hicks' values.

In a No. 2½ can heating is mainly through the sides so that the effect of the thermal resistance of the head-

[6] The product used for readings in the water-bath was the same as that for cans A, B, E, F, H, I in the retort.

space is small. It was important, therefore, to calculate the effect for a squat can for which a higher proportion of the heat passes through the ends. The 1 lb. squat can (401 x 211), with radius a = 5.0 cms. and height l = 5.5 cms., assuming the same value for the thermal diffusivity as in the previous calculations, gave the results shown in Table 4, the slowest heating point being 3.39 cms. above the base of the pack (0.64 cms. above the centre).

TABLE 4

F values for infinite and finite rate of heat transfer through headspace

1 lb. squat can (401 x 211). Initial temperature 180° F. (82.2° C.). Retort temperature 240° F. (115.6°C.). 65 minutes cook and cooled in water at 70° F. (21.1° C.) z = 18° F. Diffusivity a = 1.5 x 10^{-3} $(cm.)^2/(sec.)$.

	H. Infinite	H. Finite [7.6 B.T.U./(ft.)^2 (hr.) (° F.)]	
	Centre	Centre	Slowest heating point
Heating phase	2.56	1.43	1.32
Cooling phase	1.69	1.04	1.04
Total F	4.25	2.47	2.36

In this case, for H finite, the difference between the total F value at the centre and at the slowest heating point respectively is larger than the error expected from the calculation. It is still small, however, so that the total F value does not vary greatly between the two points.

Thus the centre of the pack, the slowest heating point or the centre of the can may be chosen as a measuring point for the experimental determinations of the lethal value of the process by the usual methods as the variation between these points is quite small.

As was expected, the effect of the finite heat transfer through the headspace on the F value calculated from the thermal properties of the pack is much greater for a 1 lb. squat can than for a No. 2½ (43% and 12% respectively). It follows that it is essential to take the thermal resistance of the headspace into account in order to obtain reliable estimates of equivalent processes for cans of different shapes.

The effect of the headspace on the equivalent volume, as defined by Hicks *(4)*, has not been calculated but it would not be expected to be large.

SUMMARY

Taking into account the thermal resistance of the headspace in a can, an expression is obtained for the temperature anywhere in the pack. By determining experimentally the temperature history at the middle of the top surface and the centre of the pack respectively, a method is given of evaluating a, the thermal diffusivity of the pack, and H, the rate of heat transfer through the headspace.

Results are quoted for a pack made from a mixture of dried beans and a bentonite suspension. Similar results have also been obtained with other packs, namely meat loaf and pumpkin.

At a retort temperature of 240° F. values of H ranged between 6 and 10.5 B.T.U./(ft.)^2 (hr.) (° F.). Of this radiation and convection alone would be expected to account for only 2.5 B.T.U./(ft.)^2 (hr.) (° F.) and distillation of water in the headspace is believed to account for the rest. This explanation is supported by measurements made in a well-stirred water-bath at 104° F. when values of H were found to range between 2.0 and 3.2 B.T.U./(ft.)^2 (hr.) (° F.).

The effects of this finite rate of heat transfer through the headspace are:

a. The slowest heating point is raised above the centre of the pack.

b. The *calculated* lethal value for any thermal process is less than that found when the thermal resistance of the headspace is ignored. The effect is greatest for squat cans and least for tall ones.

c. Although it does not affect the lethal value obtained by determining the temperature history experimentally, its effect should be taken into consideration when calculating lethal values for one can from temperature measurements made on a can of a different shape.

d. The calculated lethal value does not vary greatly between the centre of the pack and the slowest heating point so that either of these two points or, in fact, any intermediate point may be used for an experimental determination of the lethal value.

Acknowledgments

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Studies on Dehydrated Potato Granules

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The effect of processing variables and variation in sources of raw material upon the properties of dehydrated potato granules is discussed. The influence of modifying agents to improve the consistency of the reconstituted product was also studied. Calcium chloride, added to the water used in reconstitution, was shown to improve texture.

Potato granules are a dehydrated product made from freshly cooked, mashed potatoes. The present method of manufacture is the mixback process, in which the freshly mashed potatoes are thoroughly mixed with previously dried material to bring the overall moisture content to 35 to 40%. This mixture is dried in a stream of heated air. The process was originated during World War II and is still very much in a state of development, although potato granules are available both in the domestic and foreign markets.

In the dehydration of potatoes, the most critical operation is drying from the 80% moisture content of the original potato to 35 to 40%. In the mixback process, this stage of drying is accomplished by mixing the cooked potatoes intimately with previously dried material and allowing the moisture to equalize before continuing the drying. A properly comminuted mixture of 35-40% moisture can then be readily dried in a hot air stream without excessive cell damage or agglomeration.

In the present state of development of the process, the nature and condition of the raw material is a critical factor. Variations frequently encountered make it difficult to reconstitute the product to a mealy, uniform consistency, particularly under normal kitchen conditions, where the volumes are measured rather approximately, and temperatures are estimated rather than exact.

Because there is considerable variation in the characteristics of potato granules made in different localities and from different sources of raw material, this study was begun with the aim of determining the effects of processing variables, and raw materials upon the properties of the product. As the study progressed, several modifying agents were used to improve the consistency of the reconstituted product.

PILOT PLANT EQUIPMENT

A pilot plant was constructed which would allow the processing of quantities large enough to obtain data which could be used to design commercial equipment. This equipment consisted of an abrasive peeler, a steam cooker, rolls for mashing, a preliminary mixer, aging belt, final mixer, syntron feeder, pneumatic dryer, and screen. The arrangement is shown in Figure 1.

The equipment was assembled so that the operation could be made continuous. However, since most of the variables could be studied best in batch operation, thus requiring the processing of less material, most runs were made batchwise.

An abrasive peeler was used and the potatoes were peeled lightly. After peeling, tubers were trimmed of defects and sliced approximately one inch thick before steam cooking. The cooking was done at atmospheric pressure in stainless steel trays loaded 4 inches deep. Immediately after cooking the tubers were mashed between plastic coated steel rolls two feet in diameter set with a clearance of 1/16 inch. The potatoes were then cooled to room temperature and mixed with dry powder in a 6 inch conveyor having a central shaft fitted with paddle mixing blades.

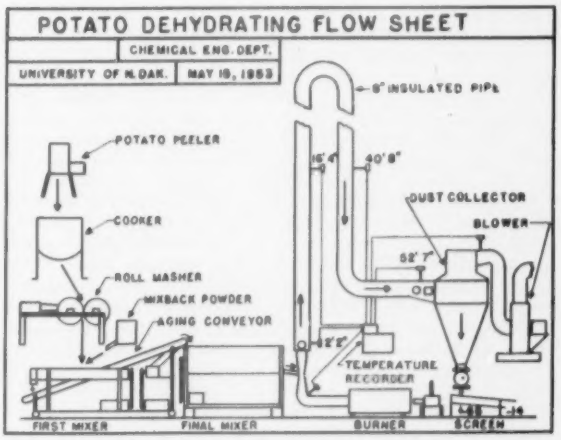

Figure 1. Arrangement of pilot plant equipment.

After mixing, the damp powder was aged either in tubs or, when running continuously, on a belt conveyor. After aging, the damp powder was given a final mix in a mixer having 2 rotating shafts, one above the other, fitted with steel pegs.

The drying was done in a vertical duct 8 inches in diameter and 53 feet long, leading into a cyclone separator equipped with an air lock for discharge of the dry powder. The air for drying was mixed directly with the combustion gases from propane and was moved by an exhauster fan located after the cyclone collector.

PILOT PLANT OPERATIONS

It was the aim of this investigation to obtain data which would assist in the design or choice of plant equipment. Difficulty was experienced, however, in scaling down some of the steps in the process. It was found in the mixing step, for example, that effective granulation depended not only upon the speed of moisture equalization between wet and dry material, but also upon the amount of material in the mixer. Similarly, in the aging step, during which moisture equalization is completed, the degree of compaction was important, and this depended upon the depth of the material on the belt or in the tubs. Since this equipment exerted such a strong influence on process variables, quantitative process data must be interpreted in terms of the type and size of the equipment used.

Cooking. The sliced potatoes were loaded 4 inches deep in stainless steel trays perforated with ¼ inch holes for condensate drainage. Care was taken not to overcook.

Mixing. In early experiments, the potatoes were added directly to the dry powder and mashed and mixed in one step.

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This method was later abandoned in favor of mashing before mixing. If potatoes are mashed and mixed simultaneously, the mixing rate must be closely controlled. The cooked material at high moisture content is rather fragile, and cells are easily browen during the mashing. The dry powder must absorb moisture from the cooked potato quickly in order to increase the resistance of the cells to mechanical breakage. On the other hand, if the moisture of the wet material is lost before the cells are thoroughly separated, they are then separated only with great difficulty and these cell aggregates usually remain intact and are easily heat damaged in drying. In addition, the rate of moisture exchange is dependent upon the moisture content of the dry material and its particle size. The combination of all these factors makes for difficult control in plant operation, and the mixing and granulation were found to be easier to control if the potatoes were mashed and cooled prior to mixing with the dry powder.

The resultant mix was considerably finer when the potatoes were mashed and cooled before mixing. Since fineness was an advantage in drying, cooling prior to mixing was favored. In the mixer used, the shaft turned at a speed of 60 r.p.m. and the material remained in the mixer 15 minutes. In most runs this mixing period was followed by an aging period on a conveyor belt (or in tubs for batch runs), for 30 to 45 minutes, and then by a final mix of 15 minutes.

Shortening the first mixing period below 15 minutes resulted in coarsening the product. The aging period apparently served to allow moisture to equalize between wet and dry material, but this equalization was inadequate unless the preliminary mixing was thorough. If the second mixing period were eliminated, coarsening again would occur, perhaps because a certain amount of adherence between cells took place during the equalization.

The time required for the mixing and aging periods depended on the type of equipment used. The planetary mixer used in some small batch runs gave adequate results with 5-minute mixing periods before and after aging. Mixing action in the larger equipment used was less efficient, and thus required longer mixing times. The time necessary for mixing also depended upon the condition of the dry powder used (coarseness, degree of cell breakage, moisture content), that of the potatoes (completeness of separation in premashing, etc.) and on the moisture content of the wet mix.

Drying. Potato granules before drying, if properly prepared, consist of individual whole cells and some cell aggregates with a moisture content of from 35 to 45%. This damp powder is easily dispersed in an air stream and loses moisture very readily down to a moisture content of 10 to 12% *(1)*. Pneumatic drying, or drying in suspension in a heated air stream, is a suitable method and has the advantage of a short retention time in the dryer, minimizing heat damage. The design of the drying duct and the velocity of air in the dryer are important in controlling abrasion damage.

Two types of pneumatic dryers were constructed from which drying data was obtained. The first consisted of 133 feet of horizontal, 8-inch duct having 9 elbows in the line and leading to a cyclone collector. The air was heated before entry by combustion of propane gas, and the air was moved through the dryer by an exhaust fan at the exit side of the cyclone. It was found that a minimum velocity of 70 feet per second was necessary to keep the powder in suspension in the horizontal pipe. Stratification of the air stream occurred and there was some abrasion and heat damage.

It was found that approximately 85% of the total drying took place in the first 33 feet of pipe and the evaporation from that point on was rather slow, as shown in Figure 2. It is apparent from this plot that drying of granules to a moisture content of 7%, that of Army specifications, is impractical in this type of dryer when using temperatures which will not damage the powder. It was noted that some heat damage occurred if the product from the cyclone collector exceeded a temperature of 120° F.

Because of the necessity of maintaining rather high velocities in a horizontal duct to keep the powder in suspension, a second drying system was assembled as shown in Figure 1.

The drying duct in this system consisted of 53 feet of 8-inch vertical duct leading to a cyclone. The feed was introduced through a venturi at the point of contraction in order that there would be more rapid dispersion of cell aggregates. The air velocity in the 8-inch duct was varied from 40 to 80 feet per second.

The attrition damage to the powder was determined at velocities of 41 and 73 feet per second by passing the powder through

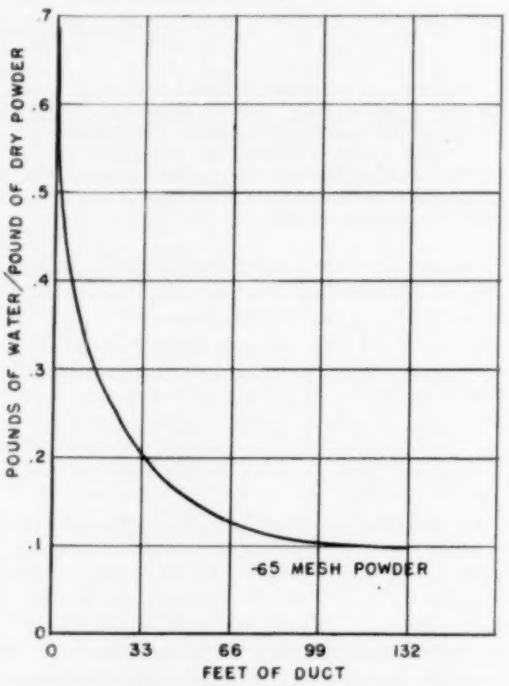

Figure 2. Moisture content vs. length of drying duct.

the dryer 10 times, using unheated air. At the end of each pass, the powder was sampled through a riffle and the percentages of moisture and free starch were determined. Free starch has been found to be a measure of broken cell content, as explained later. A plot of percentage free starch on a dry basis versus number of cycles (Figure 3) shows a slight but steady increase of broken starch at the low velocity; while the higher velocity is shown to be quite damaging to the powder, especially in the first few cycles when the moisture content of the powder was high. This indicates an advantage of a vertical drying duct over a horizontal duct, since the velocities in horizontal ducts must be necessarily high in order to keep the powder in suspension.

The following data were obtained while using the vertical drying duct:

Inlet temperature of air	250° F.
Exit temperature of air	173° F.
Pounds water evaporated per minute per sq. ft. of duct cross-section	1.75
Product temperature	118° F.
Moisture content of feed	35.0%
Moisture content of product	11.4%
Feed rate (lb./hr.)	137
Measured air rate (ft./sec.) at exit from orifice readings	43.5

Considerably higher capacities and heat economies can be obtained at higher feed rates with the product leaving at moisture contents up to 15%. Powder up to this moisture content may be handled easily and is suitable for use as mixback. Figure 4 shows the moisture content of the powder at various points in the vertical duct during drying. These results were obtained from temperature data at these points rather than by sampling the powder.

Pneumatic drying is very satisfactory for drying to 10 to 12% moisture. For completing the drying to 7% moisture or below, a dryer having a longer retention time for the powder is necessary, and a rotary dryer of either the Rotor-Louvre or flight type has been used successfully when operated under conditions such that the powder temperature remained below 120° F. Powder to be used for recycling was not dried below 10%, and only that which is to be stored need be dried to 7%.

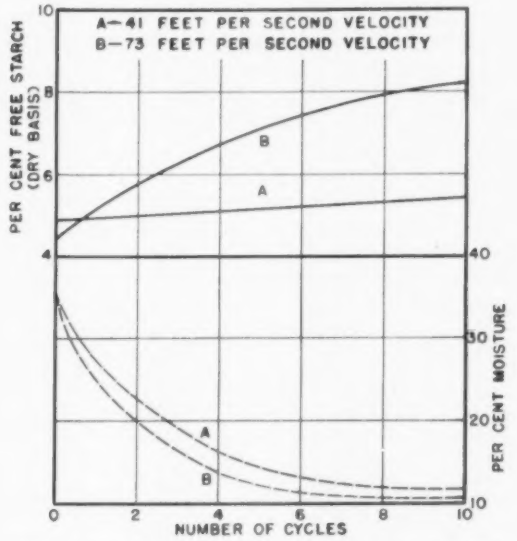

Figure 3. Attrition in pneumatic dryer—air at 75° F.

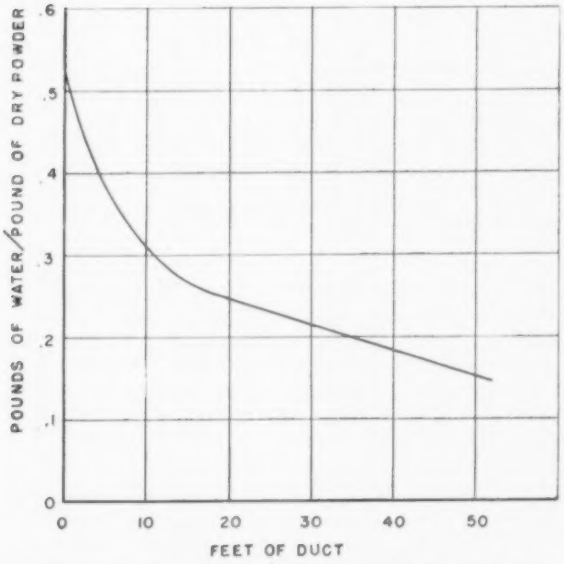

Figure 4. Moisture content vs. length of drying duct.

PRODUCT BULK DENSITY

In commercial manufacture of potato granules, difficulty is encountered at times in packing the required weight of powder in the can. In order to determine the effect of rate of drying on bulk density, 20 pounds of dry granules were mixed with water to a moisture content of 40%. The batch was divided and half was dried in an air stream with the air entering at 310° F. The other half was dried with the air entering at 140° F. A screen analysis was made on each batch, and the bulk density was run on the whole sample and on each screen fraction (Table 1).

Bulk densities were determined with a Voland and Sons Powder Density Balance. In this determination, the powder is allowed to fall from a funnel into a cup which is struck off level and weighed on a balance beam. The beam is calibrated directly in grams per cu. cm. These density values are somewhat lower than those of canned granules since there is no agitation to compact the particles during filling of the cup as there is in canning.

TABLE 1

Bulk density vs. screen size and drying air temperature

Determination	Temperature of drying	
	310° F.	140° F.
Screen analysis	*% retained*	*% retained*
on 48 mesh	0.2	0.0
48-65 mesh	0.6	0.3
65-100 mesh	4.9	3.8
100-150 mesh	28.4	24.9
150-170 mesh	24.6	23.5
170-200 mesh	26.3	29.9
through 200 mesh	15.0	17.6
	g./cc.	*g./cc.*
Bulk density (whole sample)	0.766	0.839
Bulk density (screened fractions)		
100-140 mesh	0.751	0.812
140-170 mesh	0.778	0.847
170-200 mesh	0.788	0.853
through 200 mesh	0.792	0.853

It will be seen from these data that the bulk density is determined primarily by the rate of drying. Granules dried rapidly have a lower bulk density than those dried slowly. The bulk densities of the screened fractions are greater in the smaller screen sizes, but the rate of drying rather than screen size distribution is responsible for the important variations in bulk density.

PRODUCT EVALUATION

Viscosity test. Potato granules of satisfactory color and flavor can be produced by the mixback process without great difficulty. A suitable mealy texture of reconstituted product is, however, much more difficult to attain. For this reason, considerable work has been directed at these laboratories toward determining the effect of process variables on the texture of reconstituted granules.

Since it was surmised that texture of the material would be closely correlated with its viscosity, a test was developed for determining quantitatively the viscosity of rehydrated potatoes. This test employs a Brookfield Synchro-lectric Viscometer, with which viscosity is determined by the resistance of the fluid to the motion of a rotating spindle. Since the fluid is non-Newtonian, the viscometer is used in conjunction with a Brookfield Helipath Stand, designed to lower the viscometer spindle through the fluid during the measurement. The spindle is in the form of an inverted T, and it traces out a helical path as it is lowered, thus always moving through fresh material. The torque required to rotate the spindle is registered on the viscometer dial and may be converted to centipoise units. For non-Newtonian fluids, however, the measured viscosity varies with the particular spindle used, and centipoise values can be compared only for measurements with a given spindle and viscometer speed of rotation. In this work, however, the range of viscosities that is of interest can be covered with a single spindle and viscometer speed.

PROCEDURE

In the comparison of different samples, it was found desirable to determine for each sample a complete reconstitution temperature*-viscosity curve, rather than a viscosity at a single temperature. Thus, for a given sample, specimens were reconstituted at 10° temperature intervals from 140° to 190° F. and viscosity measurements for each made at 130° F. The time lapse between reconstitution and measurement was maintained at ten minutes.

The procedure used is as follows: An 80 g. sample of potato granules of known moisture content is weighed (to 0.1 g.) and rehydrated with a quantity of distilled water sufficient to bring the overall solids content to 15.3%. The water is placed in a 1½ quart stainless steel mixing bowl and brought to the desired weight and reconstitution temperature on the scale just before mixing.

The powder is placed in a glass hopper (a funnel with a large opening which is stoppered with a cork) held in a ring stand. The mixer is a Hamilton-Beach "Mixette" 3-speed mixer and is run at a speed of 620 r.p.m. (speed 2). When the water in the bowl has been adjusted to the correct temperature and weight, the operator places the bowl beneath the hopper, starts the mixer, places it in the water and removes the cork, allowing the powder to fall into the water. The mixer is rotated rapidly around the bowl during the mixing time (measured with a stop watch) of 20 seconds. The rotation should be begun an instant before the powder hits the water surface, in order to set the water in motion to promote immediate dispersion.

After mixing, the rehydrated material is folded gently several times with a broad steel spatula (blade 1-inch wide) to even out moisture differences.

The bowl is cooled and the sample transferred to a 400-ml. beaker, in which the determination is made. The spatula is used to effect the transfer, and is pressed down with each increment to express air pockets. The beaker is then placed under the spindle of the viscometer, which is started when the total lapsed time after mixing is ten minutes.

Viscosity is determined with a Brookfield Synchro-lectric Viscometer with the Brookfield Helipath Stand. The beaker of mashed potato is set under the spindle, which is lowered about one-third of the way through the material before the viscometer is started. The number 3 spindle (horizontal bar 21 mm. long) is used, and the viscometer speed is 4 r.p.m. The viscometer is read on each revolution of the dial. Readings are taken only on the middle third of the material, since results obtained in this way were most consistent, perhaps because of cooling near the top and bottom of the beaker on standing. The temperature of the central material is then measured, and should be within two degrees of 130° F. Scale readings (0 to 500) multiplied by 10 give viscosity in poises, according to manufacturer's data, although for non-Newtonian fluids the viscosity reading obtained varies with the spindle used and the viscometer speed of rotation.

DEVELOPMENT OF PROCEDURE

The viscometer system described gave highly reproducible results on a uniform material. The greatest difficulty in the viscosity testing of reconstituted potato granules was in the preparation of reproducible, uniform rehydrated samples. Better texture was obtained by stirring in the powder with a fork than by beating with a mechanical mixer since the latter tended to cause some cell damage. The former method was not employed, however, because of lack of uniformity of the resulting product.

The principal variables affecting viscosity of rehydrated granules were found to be: variety and quality of raw material, broken cell content of granules, solids content of the rehydrated product, temperature of reconstitution, particle size distribution of granules, degree of heat damage to granules during drying, and moisture retention capacity. The viscosity was also affected by substances added during processing, such as citric acid, calcium chloride, benzoyl peroxide, and glycerol monolaurate. Viscosity of rehydrated potatoes changed very rapidly with percent solids in the rehydrated product, as will be seen on examination of Figure 5, which gives

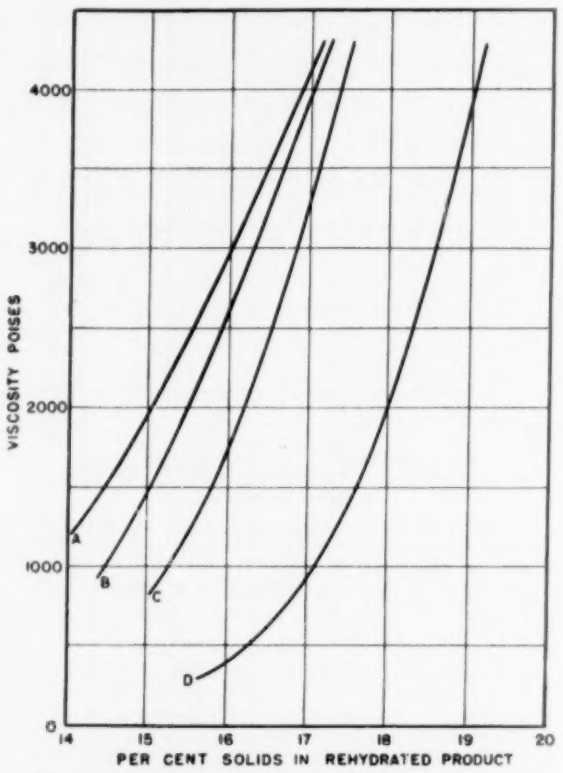

Figure 5. Viscosity of rehydrated granules versus solids content of rehydrate.

viscosity vs. percent solids for several samples from different sources. It was therefore necessary to use a constant solids content in any series of determinations in which other variables were studied. The amount of water used was calculated in each case from the weight of dry solids in the 80-g. sample, assuming 15.3% solids in the rehydrated material.

This solids content, although lower than that of freshly mashed potato, was the highest which gave reproducible results. Viscosity readings on a single test fluctuated widely when higher solids contents were used. Consistent readings were not obtained on freshly mashed potatoes because they could not be thoroughly whipped without excessive cell damage.

From Figure 5 it may be seen that a wide variation in viscosity is possible for different samples at the same solids content on rehydration. It was concluded from the present work that this variation is not entirely a matter of product quality, but involves what might be termed

* Reconstitution temperature in this report is defined as temperature of water added.

"moisture retention capacity" of a sample. As an illustration of this point, Samples A and D in Figure 5 show a pronounced difference in viscosity but showed no particular difference in free starch. Sample D could be reconstituted to the viscosity of Sample A by using less water, and the textures of the two samples would be comparable. Sample D was made from high specific gravity, high solids potatoes; while Sample A was made with low specific gravity, low solids potatoes. It is thought likely that a sample made from high moisture potatoes might take up water more readily on reconstitution than one made from low moisture potatoes, and therefore give a higher viscosity on reconstitution. This higher viscosity would not necessarily be indicative of better quality, but would simply show that the product from the low moisture potatoes should be reconstituted with less water than the other.

In Figure 6 the viscosities of 6 samples from different sources are plotted vs. temperature of the water used during reconstitution. Since the viscosities vary so

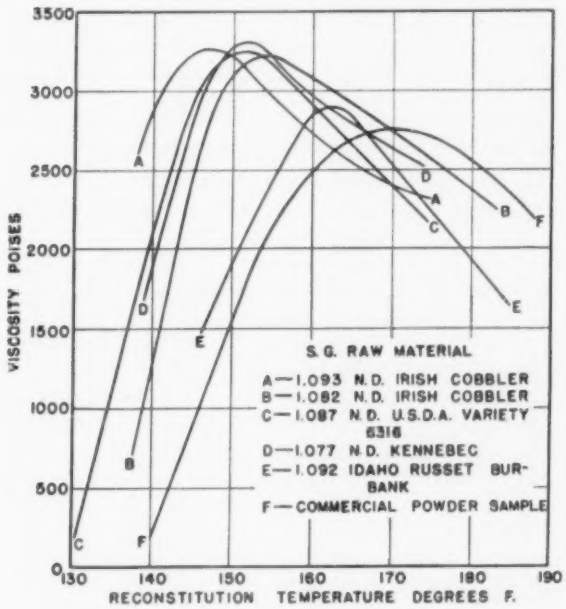

Figure 6. Effect of raw material on viscosity.

widely, it is apparent that a universal recipe for reconstitution would work to the disadvantage of many products.

To utilize the viscosity test for determination of product quality, it was deemed necessary, when comparison of samples from different sources was to be made, to determine for each sample a complete viscosity-reconstitution temperature curve rather than a viscosity at a single temperature. The shape of a viscosity-temperature curve should be an indication of quality. It is desirable to have a product which will reconstitute to a good viscosity over as wide a range of water temperatures as possible, as most ultimate users of the product would be unlikely to measure the water temperature accurately. Thus a broad curve with a wide peak and a viscosity maximum at a high temperature is desirable, and a narrow peak with a maximum at a lower temperature is not.

The data of Figure 7 demonstrate the reason for the specification of a mixing time of exactly twenty seconds.

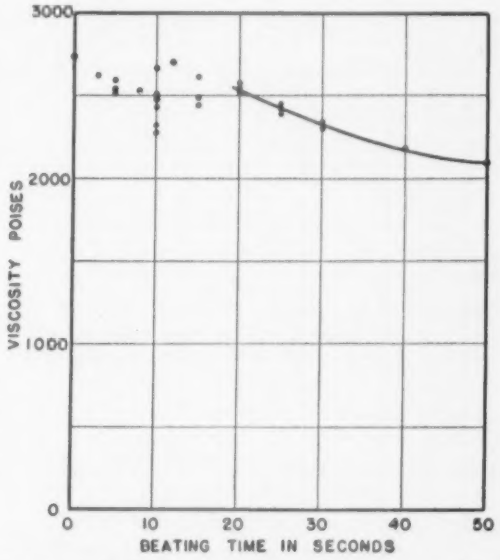

Figure 7. Viscosity of rehydrated granules as a function of beating time.

For times less than 20 seconds, results were highly inconsistent due to incomplete mixing. Mixing times above 20 seconds gave consistent readings for a given sample, but the viscosity fell off with increasing beating time, due probably to cell breakage on extended mixing.

The effect of free starch from broken cells is shown in Figure 8. To each of two samples from widely different sources, 10% of cooked potato starch was added before reconstitution. Viscosity-temperature curves were determined for both the original samples and the samples containing the added free starch. The results show that the viscosity was considerably decreased in both cases by the addition of starch. Samples to which were added ball milled granules or potato flour also showed very striking decreases in viscosity due to the added starch.

Free starch test. A method for determining the amount of starch taken up by water when the sample of dehydrated granules is extracted at 150° F. was developed by the U. S. Department of Agriculture's Western Regional Research Laboratory, Albany, California. The water-soluble starch is an indication of the degree of cell breakage in the sample, since only starch freed by cell breakage is taken up by water. A sample is mixed in water at 150° and allowed to settle, the supernatant liquid being then analyzed for starch colorimetrically with iodine. Although this color reaction is exhibited only by the A-fraction of the starch, the proportion of A-fraction should be fairly constant and results valid, as long as the instrument is calibrated with potato starch.

Results from this test show merely free starch extractable with water under the test conditions, and the amount of starch thus extracted is a continuous function of the temperature used, time of mixing, and other variables. Readings thus obtained, however, give an index of relative amount of broken cells and serve as a basis for comparing degree of cell breakage between samples

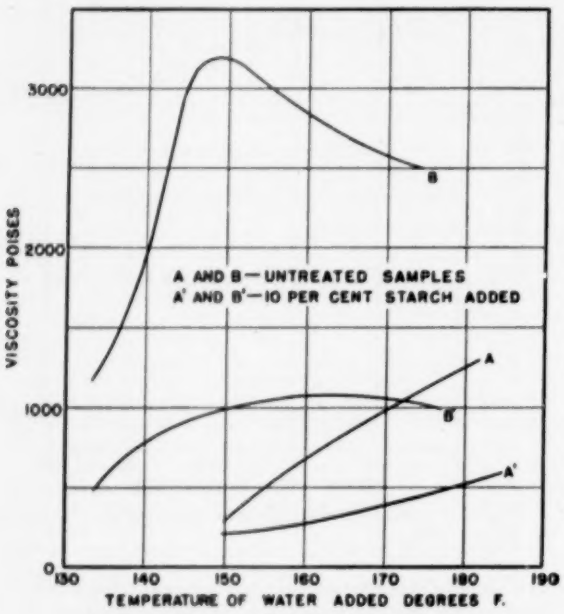

Figure 8. Effect of free starch on viscosity.

although the figures given should not be interpreted quantitatively as percent of broken cells in the sample.

The following procedure is slightly modified from that developed by the Western Regional Research Laboratory: In a 600-ml. beaker are placed 500 ml. of distilled water at approximately 170° F. The water is agitated with a motor-driven stirrer at low speed (about 150 r.p.m.) and allowed to cool. When the temperature reaches 150° F., a 1-g. sample of granules is added by pouring slowly into the path of the stirrer blade. The stirring is continued from 5 min. without further heating, after which the stirrer is removed and the beaker let stand for 20 min. to allow settling. A portion of the supernatant liquid is then decanted off, and filtered on a coarse filter paper, 10 to 15 ml. of filtrate being collected.

An iodine solution is prepared by diluting 1 ml. of 0.02 N iodine (in KI) with 44 ml. of water in a 125 ml. Erlenmeyer flask. To this 45 ml. of solution is added 5 ml. of the filtrate collected above. The solution is shaken and allowed to stand for 15 min. The percent transmittance is then determined at a wavelength of 6700 A. with a Coleman Model 11 Spectrophotometer. This value is converted to percent starch from a calibration curve obtained with pure cooked potato starch. All results are calculated to the dry basis.

MODIFICATION OF TEXTURE WITH ADDITION AGENTS

Texture and viscosity of reconstituted granules are dependent upon several factors and, of these, the following have been investigated in this study: water absorbing capacity of granules made from different varieties and from different localities; effect of broken cells upon viscosity; effect of pH of water in reconstitution on viscosity; and effect of addition agents, such as benzoyl peroxide, calcium chloride, and potassium bromate.

Moisture retention capacity of granules is very important in obtaining satisfactory texture in reconstitution. If the water of reconstitution is in excess of the moisture retention capacity, the reconstituted product is thin and soupy, while too small an amount of water in reconstitution results in a heavy product of poor texture.

Increasing the alkalinity of the water used in reconstituting the powder has an adverse effect upon the viscosity. A pH of 9.0 to 9.5, which is common in municipal water softened by the lime-soda process, is sufficient to lower not only the viscosity but also the temperature of maximum viscosity obtained when distilled water is used in reconstitution.

Figure 9 shows the effect of pH of the water in which the powder was reconstituted upon viscosity. The samples at a pH of less than 7 were acidified with citric acid, the sample at a pH of 9 was tap water, and sodium carbonate was used to obtain a pH of 11. It is seen that increasing the pH results in poorer viscosity and that the maximum in the curve is at lower reconstitution temperatures, which is undesirable.

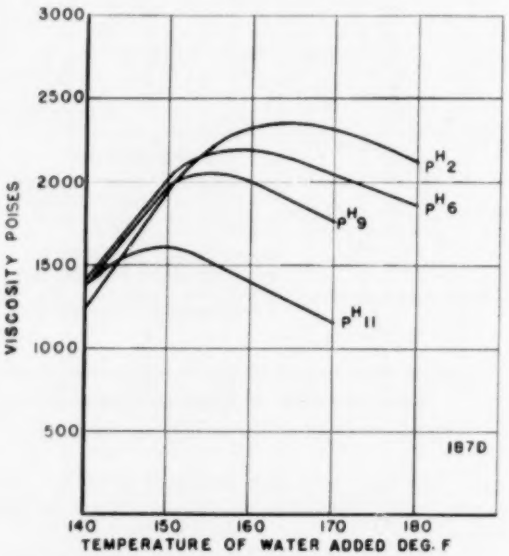

Figure 9. Effect of pH of water on viscosity.

In an attempt to improve the mealiness of the reconstituted granules and perhaps increase their tolerance to

higher temperatures during reconstitution, calcium chloride was added in one case to the water of reconstitution and in the second case to the damp powder before drying. Calcium chloride, when added to the water of reconstitution to make an 0.25% solution, increased the viscosity considerably (Figure 10). The temperature of maximum viscosity, however, remained unchanged, showing that the tolerance to higher temperatures had not been increased. When sufficient calcium chloride was added to bring the damp powder to .07% $CaCl_2$ prior to drying, very little effect was noted. The calcium chloride was added as a solution sprayed into the powder during mixing; and when it was found that there was no effect, it was thought that perhaps the calcium chloride was not being evenly distributed. In another trial, a calcium chloride solution was added to the dry powder to bring the moisture content up to 35%. No cooked potato was added. This was dried and little effect on the viscosity was noted. Analysis of the powder showed that practically all of the calcium was in insoluble form.

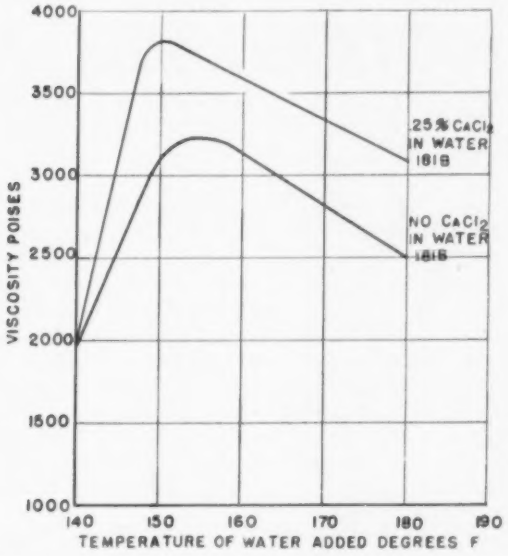

Figure 10. Effect of calcium chloride in water on viscosity.

Several mild oxidizing agents, such as potassium bromate and benzoyl peroxide, were added to the powder in order to observe their possible effects on the position of the viscosity temperature curves. The benzoyl peroxide was found to be an effective bleach but the viscosities were affected adversely by both agents and both products developed off-flavors rapidly upon storage.

CONCLUSIONS

1. Potato granules of satisfactory color and flavor can be produced readily, but proper texture of reconstituted product is difficult to attain.

2. Mashing and cooling of freshly cooked potatoes before mixing with dry powder gives better granulation than simultaneous mashing and mixing.

3. An aging period between two mixing periods is necessary for proper granulation.

4. A vertical pneumatic dryer is suitable for drying from 35-40% to 10-12% moisture.

5. Cell abrasion in drying is greater at higher powder moisture contents and at higher air velocities.

6. The texture of reconstituted granules may be evaluated by the determination of viscosity as a function of the temperature of reconstitution.

7. The pH of the water used in reconstitution affects the texture, high pH lowering the viscosity.

8. Calcium chloride improves the texture when added to the water of reconstitution, but forms an insoluble residue when added to the powder before drying.

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1. Moisture, dried products. Association of Official Agricultural Chemists, Sixth Edition, page 598.

Notes and Letters

A Modification of the Iodine Titration Method for the Determination of Sulfur Dioxide in Dehydrated Cabbage

To assure improved retention of color and flavor in dehydrated cabbage, processors commonly use some form of sulfur dioxide. A method for the rapid and accurate determination of this added material is necessary in commercial plants preparing dehydrated cabbage and in laboratories where research upon it is being done.

A method for the determination of sulfur dioxide in dehydrated vegetables was developed by Prater *et al. (2)*. Their method involved 2 titrations with iodine. One aliquot of the sample was titrated to measure the total reducing materials. Acetone was added to the other aliquot to bind the sulfur dioxide, and the reducing materials other than sulfite were then titrated. The difference between the titrations was a measure of the sulfur dioxide present. Unfortunately, the acetone-bisulfite complex is not completely stable and gives a very fleeting end point. Results are dependent upon several factors such as speed of titration, speed of stirring, strength of the iodine used, and judgment of the analyst.

The more stable formaldehyde-bisulfite complex used by Potter and Hendel *(1)* for dehydrated potatoes is not suitable for cabbage *(2)*.

The method presented below is a modification of the iodine titration method:

In each of two 600-ml. beakers suspend 8 g. of ground dehydrated cabbage in 400 ml. of water and add 5.0 ml. of 5*N* sodium hydroxide to each. Stir gently, being careful not to beat air into the solution, and let stand 20 minutes. To one of the samples add 7.0 ml. of 5*N* hydrochloric acid, stirring to avoid local acid concentration. Add 10 ml. of 1% starch solution and titrate immediately with 0.05*N* iodine to a definite blue color. It is important that the acidified sample be titrated at once, before recombination occurs.

To determine the reducing material other than sulfite, the second sample is acidified in the same manner, but instead of using a binding agent at this point to form a sulfite complex, add 2 ml. of 3% hydrogen peroxide to oxidize the sulfite to sulfate. The sample is now titrated with iodine to a definite blue color. Since the sulfite has been oxidized to sulfate, there is no "fleeting" end point.

Fresh cabbage samples, obtained from various sources, were dried by a method approximating commercial practice except that no sulfur dioxide was used.* Tests were made to determine whether, in such samples, hydrogen peroxide oxidizes iodine-titratable materials other than sulfur dioxide. Two aliquots from each sample were analyzed. To one aliquot, acetone was added; to the other, hydrogen peroxide. The iodine-reducing materials were then determined in each sample by the regular titration procedure. The data are given in Table 1.

TABLE 1

The titration of iodine-reducing materials in cabbage extracts in the presence of acetone and hydrogen peroxide

Sample	Ml. of 0.05*N* iodine used in titration	
	40 ml. acetone present	2 ml. of 3% hydrogen peroxide present
1	3.80	3.86
2	4.65	4.60
3	5.10	5.26
4	6.56	6.38
5	5.04	4.99
6	4.52	4.38

It may be observed from Table 1 that iodine titration of samples of unsulfited cabbage where acetone is present are the same as those where hydrogen peroxide has been added.

A blank was prepared with water, alkali, acid, starch, and hydrogen peroxide as usual but with no sample. To this blank was added 10 ml. of potassium iodide solution of the same concentration as that of the iodine titrating solution. No blue color developed within 30 seconds after the addition of the potassium iodide solution. This test shows that the iodine titrating solution is stable until well after the titration of the nonsulfite iodine reducing materials has been completed.

The proposed method was compared with the acetone complexing method in the analysis of samples containing various amounts of sulfite. The data obtained are given in Table 2.

* The author is indebted to Paul W. Kilpatrick for the preparation of the unsulfited dehydrated cabbage samples.

TABLE 2

The sulfur dioxide contents of dehydrated cabbage samples, determined by the iodine titration method with comparison of acetone and hydrogen peroxide procedures

Sample	Parts per million of sulfur dioxide	
	With acetone	With hydrogen peroxide
A	3376	3424
B	3382	3376
C	3088	2944
D	3200	3280
E	400	400
F	3936	4040
G	5684	6470
H	1416	1624
I	224	217
J	2704	2723

In general the two methods give similar results. However, the acetone-sulfite complex is not sufficiently stable to give a good end point. Even experienced analysts have difficulty in deciding when the nonsulfite iodine reducing materials have been titrated and a minimum of sulfite included. At best it is a compromise. Any sulfite included in the titration of the nonsulfite iodine reducing material gives a sulfite value low by that amount as shown by the following method of calculation. When a sample of 8 g. is used [(ml. of iodine to titrate sample)-(ml. of iodine to titrate sample containing binding or oxidizing agent)] X normality of iodine X 4000 = p.p.m. of sulfur dioxide.

In samples G and H the same value for "ml. of iodine to titrate sample" was used in both methods of analysis. However, a much higher value for "ml. of iodine to titrate sample containing binding or oxidizing agent" was obtained for the titrations in which acetone was used to bind sulfur dioxide as compared to the titrations in which the sulfur dioxide was oxidized with hydrogen peroxide.

In addition to giving an easily recognized end point the peroxide is cheaper and does not present a fire or other organic-solvent hazard.

December 14, 1953.

EARL F. POTTER
Western Utilization Research Branch
Agricultural Research Service
U. S. Department of Agriculture
Albany, California

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1. POTTER, E. F., AND HENDEL, CARL E. Determination of sulfite in dehydrated white potatoes by direct titration *Food Technol.*, **5**, 473-475 (1951).
2. PRATER, A. N., JOHNSON, C. M., POOL, M. F., AND MACKINNEY, G. Determination of sulfur dioxide in dehydrated foods. *Ind. Eng. Chem., Anal. Ed.*, **16**, 153-157 (1944).

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SELECTED ABSTRACTS

(Continued from page 24 preceding technical papers)

for their development the presence of the trace element and a fat metabolite and were readily transmitted to other rabbits by injection of the cancerous pulp into the peritoneal cavity.

Liver lesions following intravenous administration of polyvinyl pyrrolidone (PVP).

GALL, E. A., ALTEMEIER, W. A., SCHIFF, L., HAMILTON, D. L., BRAUNSTEIN, H., GIUSEFFI, J., AND FREIMAN, D. G. *Am. J. Clin. Pathol., 23,* 1187-98 (1953).

Each of *22* patients with chronic nonfebrile disorders of varied nature unrelated to the liver or blood-forming organs received a single infusion of 1000 ml. of normal saline contg. 3.5 or 4.5% of PVP. Control biopsy specimens of the liver procured prior to the infusion were compared with postinfusion specimens obtained at intervals of 1.5-13 mos. Histologic studies of the liver revealed the appearance of basophilic globular deposits ranging up to 50 μ in diam. These lay within Kupffler cells or free in the sinusoids and were occasionally accompanied by a mild inflammatory exudate. The deposit rarely appeared in the liver earlier than 3 mos. after the infusion but was encountered almost uniformly in specimens obtained after an interval of 6 mos. Histochem. studies lend wt. to the belief that the material deposited represents storage of PVP.

Serious poisoning by hexachlorocyclohexane. Clinical and laboratory observations on five cases.

DANOPOULOS, E., MELLISINOS, K., AND KATAS, G. *Arch. Ind. Hyg. and Occupational Med., 8,* 582-7 (1953).

The symptoms of poisoning by benzene hexachloride (B.H.C). were seen in the gastrointestinal system and mainly in the nervous system. In one case complete atrophy of the optic nerve was noticed. B.H.C. causes an inhibition of development of the cells of the red series in the bone marrow, resulting in anemia. B.H.C. has a toxic effect on the heart muscle, as shown by the electrocardiograms for 3 of our 5 patients as well as by the histologic examn. of the cardiac muscle in the first case after the patient died. Poisoning by B.H.C. causes an acceleration of the erythrocyte sedimentation rate.

Perspective versus caprice in evaluating toxicity of chemicals in man.

SEEVERS, M. H. *J. Am. Med. Assoc., 153,* 1229-33 (1953).

There is risk involved in using any chemical in food since toxicity expts. on animals are not adequate guarantees. We must therefore accept the soln. of "limited use" acceptance until sufficient data in man are collected.

FOOD AND FOOD TECHNOLOGY

COCOA PRODUCTS

The proper use of lecithin in chocolate manufacturing.

LIEBIG, A. W. *Mfg. Confectioner, 33,* 47-8, September, 1953.

The principal consideration of importance during the earlier stages of manuf. is that temps. in excess of 70° C., such as are quite common in conching practice destroy the effect of the lecithin. If high temp. treatment of the chocolate is practiced, such as heat treatments at temps. of up to 100° C., an early addn. of lecithin can cause most disagreeable flavor effects. A chem. change apparently takes place, resulting in the formation of a flavor which calls to mind some of the exts. commonly used for soup flavoring purposes.

COFFEE

The composition of coffee oil and its component fatty acids.

KHAN, N. A., AND BROWN, J. B. *J. Am. Oil Chemists' Soc., 30,* 606-9 (1953).

The oil, as obtained by extn. of coffee grounds with solvents, contains over 5% of unique unsaponifiable material which without preliminary removal makes the oil unsuitable for many purposes. It was shown that the unsaponifiable and glyceric components can be sepd. by mol. distn. A specimen of the Me esters of the fatty acids of the oil was examd. by the ester distn. fractional crystn. technics. The compn. of the component fatty acids was calcd. The oil contains 46% of linoleic acid. Satd. and unsatd. acids of the C_{20}, C_{22} and C_{24} series are present in coffee oil in small amts.

DESSERTS

The effect of homogenized milk upon the viscosity of cornstarch puddings.

JORDAN, R., WEGNER, E. S., AND HOLLENDER, H. A. *Food Research, 18,* 649-58 (1953).

Puddings made with homogenized milk and the proportion of cornstarch to milk typical of household recipes were more viscous when hot and firmer when cold than similar puddings made from nonhomogenized milk. The degree of difference in the viscosity and firmness of the puddings made with the *2* kinds of milk was found to vary with the concn. of the cornstarch.

FLAVORS AND FLAVORING

Apparatus and procedure for separation and estimation of volatile components.

GUADAGNI, D. G., AND DIMICK, K. P. *J. Agr. Food Chem.,* 1169-70 (1953).

A vacuum distn. app. for the sepn. of volatile flavor compds. from fruit products was developed which may be used as a flavor stripper or a concentrator for heat-sensitive substances and can be operated under a closed system at temps. of 25°-30° C. By use of this app. essentially all the volatiles from fruit samples may be removed without alteration due to heat damage such as occurs during steam distn. at atm. pressure.

Food flavoring materials.

World Fisheries Abstr., 4, 2, July-August, 1953.

An American has patented a process to change the typical flavor of the fish for one similar to beef. The fish are cooked to free the fats and sep. the oils by solvents. Then both substances are hydrogenated to eliminate their flavor and mixed with protein exts. or Na glutamate. The final product can be kept in hermetically sealed jars or cans, or prepd. as a dry smoked powder.

FROZEN FOODS

Ascorbic acid and physiological breakdown in the fruits of the pineapple.

MILLER, E. V., AND HEILMAN, A. S. *Science, 116,* 505-6 (1953).

Cold storage causes a loss of ascorbic acid and this constitutes the first phase in the development of low temp. injury.

Can tomatoes be frozen successfully?

NICHOLAS, J. E. *Canner, 117,* 16-17, November 16, 1953.

Preservation of whole or sliced tomatoes and tomato juice by freezing is such a new process that the technic probably will require further improvement. Tomatoes were considered something which could not be properly handled in the frozen state. Nevertheless, the tomato either whole, sliced, cubed or in the form of juice has been successfully frozen and has appeared palatable and suitable for culinary use, comparing very favorably in quality with other frozen fruits and vegetables.

LEGISLATION

Review of state pesticide regulations.

J. Agr. Food Chem., 1, 740 (1953).

Information is given on the general provisions of the regulations of the various states, especially regarding registration and labeling requirements. Wherever possible, the agency or group responsible for administration of the regulations is listed.

MILK AND MILK PRODUCTS

Nonsouring milk.

Today's Health, 31, 14, December, 1953.

Cows fed a vitamin element costing a penny a month, give milk that keeps without souring two to four times longer. The cows were given menadione, a synthetic that resembles vitamin

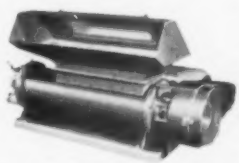
(Continued on page 30)

Best for Every Tomato Product...

fmc SPECIALIZED TOMATO PREPARATION & PROCESSING EQUIPMENT

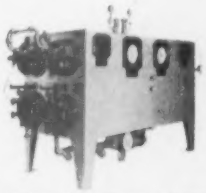
If you pack any tomato products, you are probably operating some of the FMC tomato equipment described here. For there is an FMC *Specialized* item for practically every stage in the preparation and processing of tomatoes and all tomato products. Each is engineered and built to meet the most exacting requirements, and to deliver highest quality products at lowest operating, maintenance and replacement costs. For the best in equipment for every tomato product, specify FMC—your key to Food Equipment.

FMC Pulpers and Finishers—Heavy duty frame, rigid construction. High capacities: Pulpers 5 to 20 tons per hr. Finishers 20 to 100 GPM.



FMC Tomato Chopper—Delivers small uniformly chopped product at 25 tons per hr. Table-level feed height eliminates feed elevators.

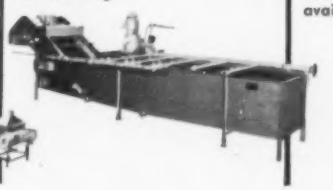
FMC Hand Pack Filler—Sturdy stainless top. Constant or variable speed drive. Sets the pace for your tomato line.



FMC Juice Processor—Continuous preheating, pasteurizing, holding and cooling in one machine. Capacities: 20-70 GPM. 1, 2 and 3-Unit Processors also available.

FMC Tomato Lines—Thorough washing, sorting and scalding on a continuous conveyor. Available in high or low pressure water systems.

FMC Flood Washer—Provides a gentle yet thorough washing action through low pressure spraying and flooding.



FMC Juice Extractors—Large screen area, extra long screw and extraction area for capacities up to 75 GPM. Lower-capacity models available.

OTHER FMC TOMATO EQUIPMENT

- Rotary Washers
- Peeling and Inspection Tables
- Scalders
- Fillers (Juices, pastes, solids)
- Heating coils and stainless steel tanks
- FMC "Sterilmatic"® Continuous Pressure Cooker and Cooler
- FMC Atmospheric Cookers and Coolers.

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Canning Machinery Division

General Sales Offices:

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SELECTED ABSTRACTS

(Continued from page 28)

K. It seems to have an antibiotic action against bacteria in milk. One pound, put into the feed or water, is enough for 50 cows for a year.

The effect of light on activated flavor development and on the constituents of milk and its products. A review.

STULL, J. W. *J. Dairy Sci., 36,* 1153-63 (1953).

Light from either natural or artificial sources causes chem. change(s) in a minor whey protein constituent of milk, which give rise to the development of an off-flavor commonly described as the activated flavor. The development of activated flavor may be retarded by the exclusion of air from milk. The flavor may be prevented by the addn. of combinations of synergists and antioxidants, such as ascorbic acid and nordihydroguaiaretic acid. Containers made of ruby or amber glass or paper offer actinic protection to milk. There is no correlation between heat treatment, salt balance, breed, fat content, or stage of lactation and the susceptibility of milk to activated flavor development.

SUGARS

Floc problem in white sugar.

SABINE, F. M., AND MAUDRU, J. A. *Proc. Am. Soc. Sugar Beet Technol., 7,* 760-6 (1952); *Sugar, 48,* 48 (1953).

Manufacturers of carbonated beverages, who constitute the second largest body of industrial consumers of white sugar, have observed that when certain sugars, both cane and beet, are used in the prepn. of such beverages a white, flocculent material settles out. This material is apparently of a colloidal nature with an isoelec. point near the pH of the beverage. A test for this condition was devised.

Photograph courtesy of American Can Company

Let better taste sell for you!

• Use Huron HVP, made from wholesome nutritious wheat, to add extra flavor to your canned salmon. Give your brand greater sales appeal through stepped-up taste appeal. Huron's Technical Service will be glad to work on your particular flavor problem. Write the Huron Milling Co., 9 Park Place, New York City 7.

HURON HVP

HYDROLYZED VEGETABLE PROTEIN

The flavor of meat from wheat

ORGANIC CHEMISTRY

Reaction between glycine and the hexose phosphates.

SCHWIMMER, S., AND OLCOTT, H. S. *J. Am. Chem. Soc., 75,* 4855-6 (1953).

The effect of the "browning" reaction on the hexose phosphates of the glycolytic cycle was studied since these sugars may account for a considerable proportion of the reducing sugars in certain vegetables. Results show that esterification of the aldehyde group of the glucose studied resulted in complete inhibition of browning. On the other hand, the presence of a phosphate ester at the primary alc. group of both glucose and fructose increases the rate of browning.

The interaction of methyl orange anions with lysine polypeptides.

WETLAUFER, D. B., AND STAHMANN, M. A. *J. Biol. Chem., 203,* 117-26 (1953).

Polylysine and methyl orange appear to combine stoichiometrically as anion exchange system. Pptn. of polylysine occurs before the polypeptide is satd. with the dye. Salts increase soly. of the anion-polylysine system independent of the salt anion. It is shown that the sol. material was not a polylysine dye complex. The manner in which methyl orange combined with polylysine varied with the chain length of the polypeptide.

The composition of honey locust gum.

ANDERSON, E., AND BLAKE, B. B. *J. Am. Pharm. Assoc., Sci. Ed., 46,* 662-4 (1953).

The gum from the honey locust tree, *Gleditschia triacanthos* (L.), is a polyuronide consisting of the Ca and Sr salts of D-glucuronic acid attached to a chain of mols. of anhydro D-galactose and anhydro L-arabinose. Analysis of the purified gum showed the presence on the av. of 3.15 units of L-arabinose and 1.87 units of D-galactose to each unit of D-glucuronic acid. On mild hydrolysis with dil. sulfuric acid most of the L-arabinose and some of the D-galactose are liberated. More vigorous hydrolysis liberates all of the L-arabinose but leaves an aldobionic acid composed of D-glucuronic acid attached through its aldehyde group to one mol. of D-galactose. The gum is found only on injured or diseased trees.

PHYSICAL RESEARCH

The stabilization of foams by proteins.

CUMPER, C. W. N. *Trans. Faraday Soc., 49,* 1360-9 (1953).

The effects of changing the protein concn. pH and ionic strength of the solns. were studied and the results correlated with previous observations on the mech. properties of films of the same proteins. An attempt is made to explain the observations in terms of three successive processes in the formation of protein films: adsorption, surface denaturation and finally coagulation. It is concluded that only surface-denatured protein is effective in stabilizing the air bubbles.

The kinetics of protein denaturation. IV. The viscosity and gelation of urea solutions of ovalbumin.

FRENSDORFF, H. K., WATSON, M. T., AND KAUZMANN, W. *J. Am. Chem. Soc., 75,* 5157-67 (1953).

The viscosities of ovalbumin solns. in urea increase very considerably with time. The first stage of this change is caused by the unfolding process which is responsible for the change in optical rotation, but the viscosity continues to increase after the optical rotation has reached a const. value. This difference in behavior is more marked, the higher the protein concn. and is caused by the gradual aggregation of the unfolded protein mols.

Studies on polyelectrolytes. III. Polyglucosamine hydrochloride.

BASU, S., AND GUPTA, P. C. D. *J. Colloid Sci., 8,* 355-63 (1953).

The viscosity, conductivity, and the effects of pH and other neutral electrolytes on the physicochem. properties of polyglucosamine hydrochloride solns. were measured. The similarity in behavior of polyglucosamine hydrochloride to those of other similarly constituted substances in which the polymer ion is oppositely charged, was shown. All these properties can be explained by the folding-chain theory of Fuoss.

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In Roccal, the original quaternary ammonium germicide, the food industry is offered a sanitizing agent that is laboratory tested and controlled. The uniform quality of Roccal means uniformly good results in doing a proper sanitizing job.

Roccal is a powerful germicide. In recommended dilutions, it is nonpoisonous, non-irritating to the skin, virtually odorless and tasteless.

Roccal can be used for every sanitizing job in processing and packaging in the following food industries: milk, cream, ice cream, butter, cheese, egg breaking, sugar, fish, poultry, fresh frozen vegetables and fruits, meat products, cereal products, candy and beverage, wherever the product comes in contact with equipment. Also to keep walls and floors sanitary.

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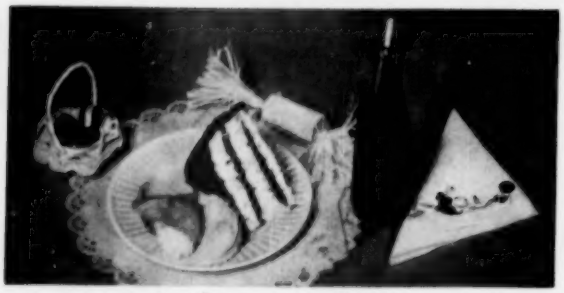

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them ask

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Our chemists and flavor experts have developed a complete, quality line of basic flavor materials, natural fruit flavors and imitation flavors to meet every need. They will gladly help you select the right flavors for your products...or work closely with you to develop distinctive individual flavors to meet your special requirements.

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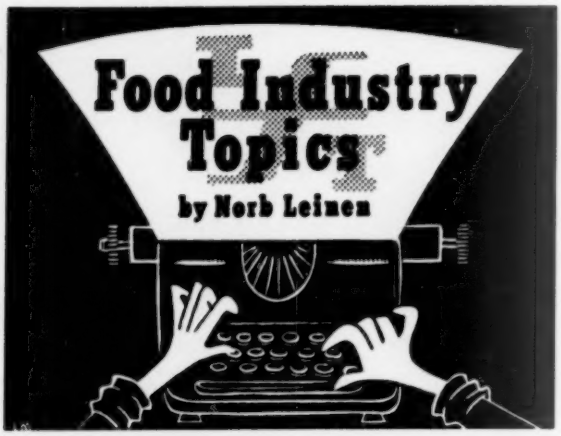


. . . *in the public interest*

From the Director, The Carver Foundation, Tuskegee Institute, Alabama, an announcement of **Graduate Research Fellowships** for 1954-55 in the fields of Chemistry and Foods and Nutrition. The Fellowships, offered for research and graduate study toward the M.S. degree, are available to graduates of accredited colleges with high scholastic records and who show promise of research ability. Fellows devote half time to supervised research and half time to graduate study, and are expected to qualify for the advanced degree within 2 years. The stipends —$1200 to $1800 annually—cover educational fees and living accommodations for one year. Further information and applications available from the Director at the above address.

◆ ◆ ◆

As a contribution to the meeting of the British Association for the Advancement of Science, to be held in Oxford, England, 1-8 September, 1954, the publishers of the quarterly scientific review *Endeavour* offer 5 prizes totaling 100 guineas for **essays** submitted on one of the following subjects: "The Upper Atmosphere," "Heat of the Earth," "Coal as a Raw Material," "Water Supply," "The Span of Life," and "Colour Photography." Essays must be in English, typewritten, under 4000 words. One entry per competitor. Address to: The Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1. Envelope should be marked "Endeavour Prize Essay," and entries must be in judges' hands by June 1, 1954. Essays should be submitted without signature, with competitor's full name, address, and date of birth disclosed in a sealed covering letter attached to essay. Successful competitors will be invited to attend the whole of the Oxford meeting, at which the prizes will be presented, and their expenses within the U.K. will be paid. Essay winning first prize (50 guineas) will be published in *Advancement of Science*, journal of the British Association.

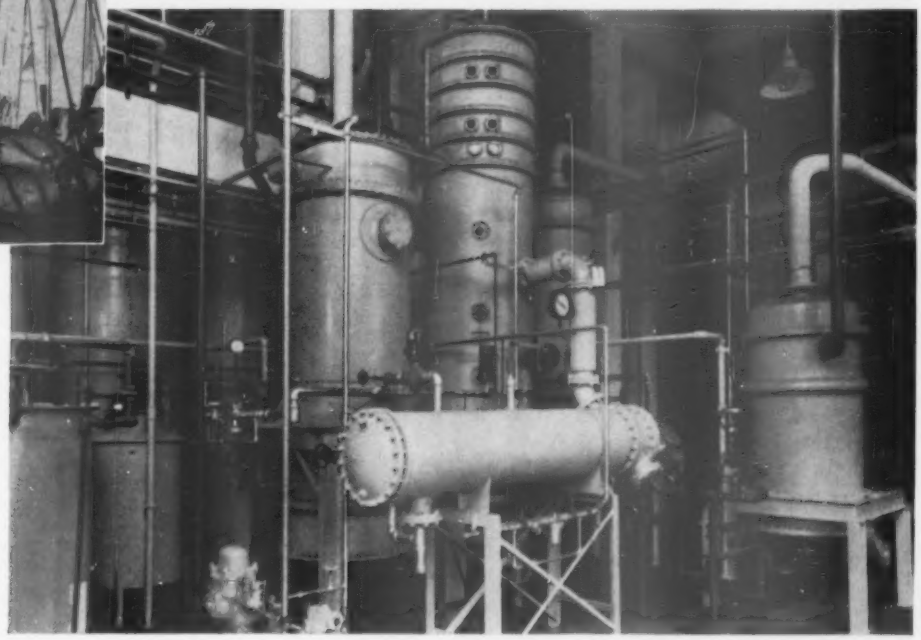
◆ ◆ ◆

Atlas Powder Company, Wilmington, Del., has set up **eight $1000 college scholarships** for science students, says Mr. Ralph K. Gottshall, president. The grants will enable outstanding students to complete their scientific education and help meet some of industry's pressing needs for technical personnel. The awards will go to students who will be seniors during the 1954-55 college year, majoring in chemistry, physics, or any branch of engineering. The program, initially being proposed to 40 colleges and universities, will be administered by the Atlas committee on scholarships chairmanned by Dr. Thomas Kennedy, director of industrial relations. Scholarships will be awarded on the basis of scholastic records and recommendations of the college staff. Extracurricular activities and financial need also will be factors. Successful candidates will be given opportunity to gain practical experience and earn additional money by working at Atlas during the summer. However, there will be no obligation to work for the firm either during the summer or after graduation, nor will Atlas assume any commitment to employ the students.

Atlas has recently published the *Proceedings* of the company's

(Continued on page 36)

Spice Shipments are not always the same...



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Pepperoyal is no ordinary soluble pepper. Use the same amount of Pepperoyal in every batch of your product, and every batch will smack of the same pure pepper flavor.

True, it is processed from prime quality pepper berries. But, its real quality distinction originates in the Griffith laboratories. The potency, purity and uniformity of pepper flavor in Pepperoyal is controlled by our exclusive process of extraction.* It assures you of the same flavor quality in every shipment of Pepperoyal, or any of Griffith's Solublized Seasonings.

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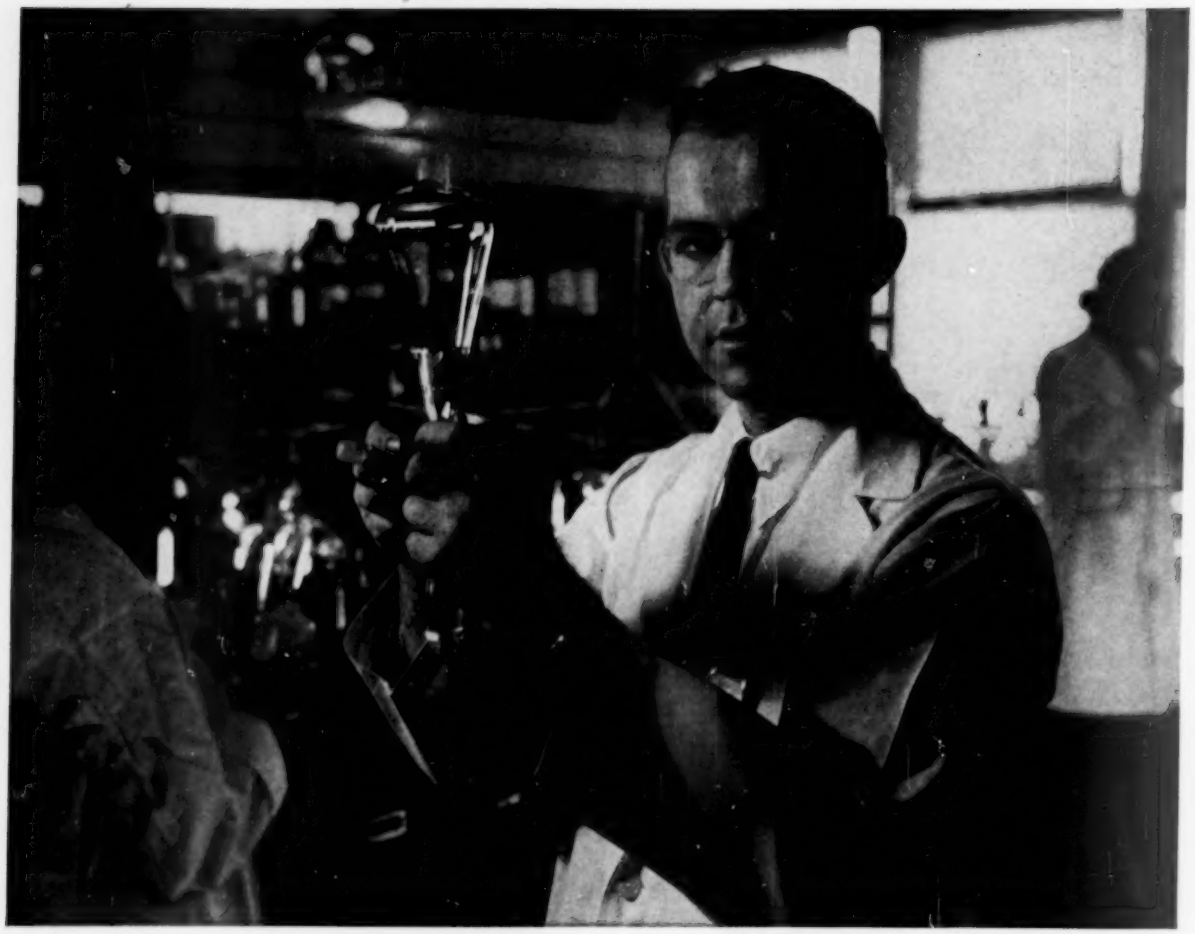

PHOTOGRAPH BY RICHARD BEATTIE

What we still don't know about cancer

—and one of the reasons why

IN THE PAST FEW YEARS, our knowledge of the nature of cancer, and how to treat it, has grown encouragingly. Patients, who would have been considered hopeless cases even five years ago, today are being completely cured. And even those who apply for treatment too late can usually live longer—and less painfully—because of modern palliative treatment.

All the same, there have been defeats as well as victories. We do not know—to take a single example—why so many more men are now dying from cancer of the lung. In 1933—just twenty years ago—lung cancer killed 2,252 men; in 1953, some 18,500. That's a great increase—which even our expanded population, and other known factors, can't possibly account for in full.

Well, why haven't we found more of the answers to cancer?

Not only because cancer is an immensely complex problem: difficult to diagnose, and difficult to treat; challenging to the best research minds.

All that is true enough. But there is another reason: *we do not* have enough money.

Last year your gifts to the American Cancer Society were more generous than ever before. But they were not enough.

You gave the Society almost twenty millions to fight a disease that—at present death rates—will kill twenty-three million living Americans.

Less than one dollar for each American destined to die from cancer. Much more is needed for research, for education, for clinics. Won't you please do *your* part . . . now?

American Cancer Society

Cancer
Man's cruelest enemy
strike back
Give

GENTLEMEN:

☐ Please send me free information on cancer.

☐ Enclosed is my contribution of $..... to the cancer crusade.

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FOOD INDUSTRY TOPICS

(Continued from page 32)

Management Symposium, held in Chicago in May 1953. Among the papers presented by industry or association experts and included in the *Proceedings* are: "Sorbitol in Pharmacy," "Use of Polyols in Synthetic Resins," "Improving Candy Quality with Sorbitol," "Automatic Quality Control in Chemical Processing," and "Corn as a Chemical Raw Material."

◆ ◆ ◆

Massachusetts Institute of Technology will again present a **3-week Special Summer Program in Food Technology,** July 12-30, 1954. During the first 2 weeks, the entire professional staff of the Department of Food Technology will participate in the lectures, demonstrations, conferences, and visits to food plants. Food origin and composition will be discussed, as well as food processing, handling, transportation, storage, and control. Emphasis will be placed on related chemical, microbiological, and engineering factors. During the third week, students may choose any one of 4 different fields of specialization, including Sanitation, Nutritional Evaluation of Food Processing, Food Acceptance and Flavor Evaluation, and Radiation Sterilization. Tuition is $150, due and payable upon notification of admission. Academic credit not offered. For particulars, write Prof. Ernest H. Huntress, Director of the Summer Session, Room 7-103, M.I.T., Cambridge, 39, Mass.

M.I.T. also sends word of a number of **graduate fellowships, research assistantships, and graduate scholarships** available to applicants who possess necessary qualifications. Recipients of fellowships are selected by the Graduate Committee on Policy. Application forms may be obtained by writing to the Director of Admissions, M.I.T., Cambridge 39. Inquiries regarding assistantships, scholarships, and fellowships should accompany the request for these forms.

◆ ◆ ◆

The 1955-56 programs covering **U.S. Government Awards under the Fulbright Act** for Austria, Belgium and Luxembourg, Denmark, Egypt, Finland, France, Germany, Greece, Iraq, Italy, Japan, Netherlands, Norway, Pakistan, Sweden, and the United Kingdom and Colonial Dependencies will be announced in July 1954. When available, application forms and additional information may be obtained from Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D. C.

◆ ◆ ◆

This year's **Short Course on Inedible Fats and Fatty Acids,** sponsored by the American Oil Chemists' Society, will be held at Lehigh University, Bethlehem, Pa., August 15-20. Technical and economic studies on fatty acid production and application will be presented by recognized authorities. Registration—$50; room and board—$35. For complete program and registration blank, write American Oil Chemists' Society, 35 E. Wacker Drive, Chicago.

◆ ◆ ◆

Fresh and frozen poultry should be **packaged to meet the requirements of self-service selling** or it will lose out to other food products in the intense competition for the consumers' food dollar, the Delaware Poultry Commission was told by Mr. D. D. Lanning, Film Department, E. I. Du Pont de Nemours & Co. He pointed out that a comparison of supermarket poultry sales with meat sales shows that cleaned, ready-to-cook poultry, attractively prepackaged to catch the shopper's eye, is necessary if poultry is to compete successfully in today's merchandising system. Mr. Lanning stated that in addition to the need for a neat package clearly marked with weight and price, the housewife today also wants to see the processor's brand name plainly visible "so she'll know he's standing behind the product."

◆ ◆ ◆

The first meeting of the newly formed **North Central Oil Chemists' Society,** attended by 132, was held on March 23 in the Builders Club, Chicago. Officers elected were K. P. Mattil, president; J. P. Harris, vice president; N. W. Ziels, secretary; and R. A. Reiners, treasurer. A. W. Haskell, A. A. Kiess, and A. A. Rodeghier were elected members-at-large. The Organization Committee appointed as standing committee chairmen: Membership, R. W. Bates; Program, H. T. Spannuth; Publicity, N. W. Ziels; and House and Arrangements, A. F. Kapecki. Speaker of the evening was Dr. Reid T. Milner.

◆ ◆ ◆

The struggle for survival among microbes can be used to aid production of beer, Frank Prescott of the technical service department of Chas. Pfizer & Co., Brooklyn, told the Master Brewers' Association of America Philadelphia District meeting. He described use of **polymyxin B**, an antibiotic derived from bacteria, in killing other bacteria which contaminate brewers' yeast and cut beer production. A tiny amount of this germ killer protects all the yeast needed for a 100-barrel fermentation and speeds the brewing process slightly. Mr. Prescott cited polymyxin as a definite improvement over dilute acid washes in preventing multiplication of unwanted bacteria in the giant brewing fermenters. Unlike most other antibiotics, which stop bacteria from reproducing themselves, polymyxin actually kills the contaminating organisms. Exhaustive laboratory and operational tests have shown that no polymyxin emerges in the finished beer but is completely removed in the filtration processes used to clarify the brew.

◆ ◆ ◆

A Baltimore City Superior Court has declared invalid Maryland laws prohibiting sale of beverages containing harmless **non-nutritive artificial sweetening ingredients**. This action was taken in a case concerning a non-alcoholic beverage made by Cott Bottling Co., Inc., containing "Sucaryl," cyclamate calcium manufactured by Abbott Laboratories, North Chicago, Ill. Dr. E. H. Volwiler, Abbott president, said this "Sucaryl" case is another step in prohibiting unfair and arbitrary state laws and regulations which discriminate against sugar-free foods designed for those who desire to restrict intake of calories. "Many states have changed their laws to permit dietary foods containing ingredients such as 'Sucaryl'," Dr. Volwiler pointed out.

◆ ◆ ◆

Food sales to American merchant ships were close to **$100,000,000** in 1953, according to a survey reported by United States Lines. The total spent for food for the passengers and crews of the 1,257 ships which make up the privately owned American Merchant Marine was an estimated $97,326,400, with meat alone accounting for an annual expenditure of close to $50,000,000.

◆ ◆ ◆

Seeking to provide members with information at this time of cocoa bean scarcity, the National Confectioners' Association has launched a series of **regional cocoa conferences** which bring to candy manufacturers facts on the cocoa bean price situation and technical information on use of compound coatings. To date, these regional conferences have been held in New York City, Chicago, San Francisco, Ft. Worth, and Atlanta. The N.C.A. is also looking forward to "the biggest candy confab of all time"—the 71st N. C. A. Annual Meeting and the 28th Confectionery Industries Exposition to be held at the Conrad Hilton Hotel, Chicago, June 6-10.

◆ ◆ ◆

A conference on "Work Experience in Higher Education" was held at Antioch College, Yellow Springs, O., February 11-13. The conference was called to evaluate the college's famed **study-plus-work program,** under which students regularly alternate classroom work with jobs secured for them in all parts of the country. Employers and alumni came from 14 states. Panels covering 14 fields of major concentration were held. One such panel examined the relationship between job experiences and Antioch's program for engineering students, and cautioned against overspecialization while at school at the expense of developing expressive ability, the imagination to originate research, and the patience to handle routine jobs.

◆ ◆ ◆

Scientists at Armour Research Foundation of the Illinois Institute of Technology, Chicago, working with Mexican scientists, have perfected a **dehydrated tortilla flour** which promises to bring about greater American appreciation of Mexican foods. The new flour, similar to prepared flour mixes available in American stores, has been well accepted by Mexican people

(Continued on page 38)

Sealva

THE NEW HERMETICALLY SEALED FLAVORS!

Sealva flavors are protected against the ravages of oxidation and atmospheric change. Sealva processed flavors appear physically as powders, yet in reality they are minute droplets of pure flavor individually hermetically sealed.

Flavor oils show no appreciable change in pure fresh character after a year's aging in Sealva form. The recently developed Sealva flavors have already achieved an amazing reputation in the dry pack food field.

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200 to 400 times more kill power than diluted water type insecticides. Completely safe to use. No odor. Spray directly on fruits or vegetables in the field, on trucks, or at docks.

Inside **WITH DIVERSEY**

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Pyrethrum plus newly developed insecticidal chemicals give Diverside greater kill power per dollar. Absolutely *safe to use. Non-toxic. Contains no DDT.* And, what's more, DIVERSEY provides you with a *complete system* tailored to your needs. Call your DIVERSEY "D-MAN" for a free demonstration today!

THE DIVERSEY CORPORATION

1820 Roscoe St., Chicago 13, Ill.

In Canada: The Diversey Corp. (Canada) Ltd., Port Credit, Ont.

FOOD INDUSTRY TOPICS

(Continued from page 36)

themselves. Because it simplifies and improves the method of making Mexican dishes, the product also is expected to become popular with American families. The Quaker Oats Company is licensed by the Bank of Mexico to manufacture and distribute the new tortilla mix in the United States. Under the brand name, "Masa Harina" (Spanish for "flour dough"), the product is now being retailed in the Southwest.

. . . *things new under the sun*

A new machine—first of its kind in the dairy industry—for **automatically casing filled cartons of milk** has been announced by American Can Co., The new packer is now being produced and installed by Standard-Knapp. It is especially designed for Canco's rectangular shape paper milk containers, eliminates packing by hand, and is capable of almost doubling the output of the present packing method, Canco reports.

◆ ◆ ◆

An **automatic food filler** with a micrometer adjustment that can increase or decrease quantity of fill while the machine operates has been announced by F. L. Burt Co., 571 Seventh St., San Francisco. The filler can be stopped instantly even in the middle of a discharge stroke without turning off the motor switch. It fills liquids or semi-solids at 10 to 30 containers per minute.

◆ ◆ ◆

A new line of **plastic superstructures and signs** for display purposes is offered by Vacuum Molding, Inc., Boonton, N. J. Known as VMI 3-D plastic illuminated signs and superstructures, the new units are made from Kodapak Sheet and feature such eye-catching elements as "molded-in" frames, "molded-in" raised letters identifying the product, fluorescent lighting which gives 100% illumination, and excellent color permanence.

◆ ◆ ◆

A tough, easily cleaned, non-crackling, oil and acid resistant, smooth, waterproof, odorless, non-toxic, and shape-holding **laboratory apron,** manufactured of Exylin plastic film by McCoy, Jones and Co., Chicago, is available by mail in "large" and "small" sizes at $2.00 each, postpaid, from Wells Exchange, 440 N. Wells St., Chicago, Ill.

◆ ◆ ◆

Minneapolis-Honeywell announces a new **heavy-duty thermostat** which accurately controls temperatures in areas where dust, corrosion, and humidity are a problem. The rugged, multi-purpose instrument is engineered specifically for use in fruit warehouses, banana-curing warehouses, sweet-potato curing sheds, sea-shore buildings, and in a wide variety of farm applications. It will control gas, oil, or stoker-fired heating plants. The new thermostat, 4″ high x 6″ wide, features corrosion-resistant parts and completely sealed MICRO switch contacts.

The company, which recently surpassed the $200,000,000 mark in gross annual sales, also offers new specification sheet 410-2 on Series 800 diaphragm motor valves with Saunders bodies, Bulletin 414-1 describing a new line of Air-O-Motor Operators, and Bulletin 1701 (which replaces Catalog 1700) containing specifications of Continental Butterfly valve bodies and the new Honeywell Series 800 diaphragm motor operators. Write Minneapolis-Honeywell Regulator Co., Industrial Div., Station 64, Wayne & Windrim Aves., Philadelphia 44, Pa.

◆ ◆ ◆

From Kieley & Mueller, Inc., 132 Genung St., Middletown, N. Y., comes news of a new **3-way, cylinder-operated valve** which combines high travel with extreme speed on both the pressure stroke and the spring return. Use of the spring return in place of double-acting cylinders permits the valve to fall in either the open or closed position as required for maximum safety under emergency conditions. Valves supplied in any machineable metal in standard sizes from ½″ to 10″, with either Teflon or greased lubricant stuffing boxes.

Thorough removal of the residue of semi-solid or solid materials such as gelatin, agar, greases, paraffin, waxes, etc., from laboratory glassware is reported for the C. R. C. Labwasher, manufactured by Westinghouse Electric Corporation for The Chemical Rubber Co., 2310 Superior Ave., Cleveland 14, O. The machine's entire operation, including washing and drying, is completely automatic, and the unit shuts itself off when the cycle is finished. Tests conducted with a purity meter indicate that glassware washed in the Labwasher retains less than one part per million of ionizable salts from most ordinary tap water. Important savings are claimed from the standpoint of

man-hours saved and substantial reduction of breakage. Standard racks handle over 90% of the different shapes and sizes of glassware used in the laboratory—as many as 60 pieces at one time. Additional specialized racks are available for such items as culture tubes and hypodermic syringes. An illustrated bulletin is available from The Chemical Rubber Company at the above address.

◆ ◆ ◆

The Dura-Mil Liquid Filler, used by the food processing industry for such operations as filling the sanitary type milk can, is now manufactured and distributed exclusively by the Turbo Machine Co., Lansdale, Pa. The Filler features a patented, revolutionary cone-shaped bowl which facilitates cleaning and affords highly efficient operation. Filling accuracy is assured by a new type valve and displacement plug which prevents foaming and spillage. Write Mr. Robert Lawrence at the above address.

◆ ◆ ◆

Accidental imbibing of toxic liquids is prevented by the new "Micropet" pipette control recently announced by National Instrument Co., 5005 Queensbury Ave., Baltimore 15, Md. In use, the pipette is slipped into the opening provided in the Micropet and fluid is drawn into the pipette by collapsing and releasing the rubber bulb. Fluid is dispensed by depressing the release plunger. A delayed action mechanism in the plunger permits the operator to control the discharge from a rapid to a barely perceptible flow. Aliquots may be dispensed with an accuracy of one-hundredth of a milliliter. The instrument is priced at $6.50 F.O.B., Baltimore.

. . . *the literary corner*

A verification of the saying, "Good things come in small packages," may be found in the February issue of *Research Comments*, a tiny, 4-page publication of Evans Research and Development Corp., 250 E. 43rd St., New York 17, N. Y. The issue at hand is devoted to an article entitled, "Making Sense of the Senses," in which the IDEA of flavor is analyzed, the BACKGROUND examined, and the FUTURE peered into.

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FOOD INDUSTRY TOPICS

A new, 8-page, 2-color booklet, Q-501, released by International Staple & Machine Co., 801 Herrin St., Herrin, Ill., illustrates and describes International's semi-automatic Staple Queen packaging machines. The staplers close center-slotted cartons top and bottom simultaneously, or close tops only or bottoms only, as needed.

◆ ◆ ◆

Sugar making is one of the world's most efficient industries, and **conveyors** contribute greatly to its efficiency. These are the conclusions reached by Mr. C. Conrad Rinelli, supervisor of export territory for Chain Belt Co., in a paper delivered at the international meeting of The American Society of Mechanical Engineers in Mexico City, March 10-12. The paper, "Conveying Equipment in Cane-Sugar Mills," describes the various kinds of conveying equipment used at both ends of the process. Copies of Paper No. 54-MEX-2 can be obtained from the Order Dept., ASME, 29 W. 39th St., New York City 18, at 50c each.

◆ ◆ ◆

Just off the press is a newly revised edition of the Dodge & Olcott Spiceolate Flavors Brochure. Containing 18 pages of listings, formulas, and tables for syrup making and salt, the new folder features a very attractive format. Spiceolate Flavors are an exclusive line of D&O water-soluble spice compositions made from pure natural essential oils and oleoresins, and are available in Natural Oils, Mixed Natural Oils, and Special Mixtures. For a copy, write Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y.

◆ ◆ ◆

An instrument of interest to the food industry is described in an 8-page, 2-color brochure put out by Crown Cork and Seal Co., Baltimore 3, Md. The CEM Headspace Analyzer was designed to sample and analyze headspace gases in food containers. It will determine oxygen in these gases in less than a minute, making it well suited for control work.

◆ ◆ ◆

A new, 8-page catalog illustrating and describing its comprehensive line of stanlard and custom-made chemical and process equipment, and steel and alloy vessels, is available from The Colonial Iron Works Co., 17643 St. Clair Ave., Cleveland 10, O. Highlighted are products engineered for such operations as agitation, distillation, evaporation, and heat transfer. Various models, developed for many leading users, are pictured.

◆ ◆ ◆

That always excellent publication, *The Givaudan Flavorist*, published by Givaudan Flavors Inc., 330 W. 42nd St., New York City 36, is devoted, in the No. 1, 1954 issue, to an authoritative article, "The Flavor of Coconut," and an account (to be continued) of "The History of Vanilla."

In the literature line, the same company also announces publication of Technical Bulletin B-1, "Flavors for Baked Goods." The 4-page bulletin contains useful information on application of basic flavoring ingredients, spice oil replacements, and the use of vanilla specialties in baked products. Application of butter, citrus flavors, and rum flavors in baked goods is also discussed and additional data on coumarin replacements is given.

The "Kold Vat," a general purpose vat that can be used to heat, cool, and mix food products, pharmaceuticals, etc, is described in a 4-page bulletin, G-495, published by Cherry-Burrell Corp. (Dept. AS-16), 427 W. Randolph St., Chicago 6.

◆ ◆ ◆

Scanning rapidly through *What's New in Food and Drug Research*, March 1954, published by Food Research Laboratories, Inc., 48-14 33rd St., Long Island City 1, N. Y., these article titles stand out: "New Data on Amino Acid Composition of Human Milk;" "Labeling of Vitamin Products to Undergo Renewed Study;" "Need Stressed for Closer Liaison Between Lawyers and Scientists;" "New Approaches to Protein Evaluation;" and "The Essential Amino Acid Spectrum of Proteins of Whole Egg and White Flour."

◆ ◆ ◆

The March 15 "Market Report" of F. Ritter & Co., 4001 Goodwin Ave., Los Angeles 39, Calif., contains latest price information on essential oils, concentrated citrus oils, essential aromatics, and oleoresins and resinoids. In addition, the Report provides information on several of the firm's products, including Orange Neoarome Oil, Pure Butter Derivatives, Pure Maple Concentrate, and True Fruit Concentrates. For a copy write to P. O. Box 12696.

◆ ◆ ◆

The March issue of **Economic Horizons,** monthly publication of The Jewish Agency for Palestine (Economic Dept.), 16 E. 66th St., New York City 21, notes that peanut butter will be the latest addition to the line of products manufactured by the Mata Factory of Foodstuffs, Tel Aviv, Palestine. Established in 1936, privately owned Mata has become one of Israel's major foodstuff manufacturers and owns or controls 3 factories which provide 45% of the margarine and 57% of the processed cheese consumed in Israel. Mata is seeking an investment of $20,000 to acquire American machinery for its new peanut butter venture.

◆ ◆ ◆

American industry has **failed to disperse enough** says the tough-talking March issue of *The York Report*, published by York Engineering & Construction Company and York-Gillespie Mfg. Company, 39th St. & Allegheny Valley R. R., Pittsburgh 1, Pa. The *Report* concedes progress toward dispersal, and points out that some plants cannot be moved from present sites. It cites this fact as creating greater obligation for others to disperse. The *Report* suggests that when a company cannot move out of a target area quickly funds accumulating for replacement be used to start pilot plants outside of danger areas. Then, as existing facilities wear out, safer ones will come into being. In the meantime, the company will have the insurance against fires, floods, and other disasters that an alternate plant provides.

◆ ◆ ◆

"Solutions to Sticky Problems," a 20-page booklet published by Brookfield Engineering Laboratories, Inc., Stoughton, Mass., passes along readable information on such subjects as "How the Brookfield Viscometer Works," "A Simple Calibration Check," "Making a Good Measurement," "Viscosity and Temperature," "Coming to Grips with Rheology," and "Laminar and Turbulent Flow." For a copy, write Mr. Richard Minard at the above address.

. . . *building up and branching out*

The A. E. Staley Manufacturing Co., corn and soybean processor, reports a 1953 net profit of $4,424,214 on sales of $130,463,700. Net profit for the year was about 24% above the

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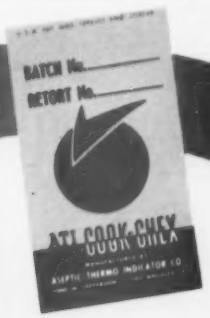

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FOOD INDUSTRY TOPICS

1952 earnings of $3,572,314. Commenting on the firm's 1954 business outlook, Mr. A. E. Staley, Jr., president and board chairman, noted that the large 1953 corn harvest should be more than adequate to meet feeding, industrial, and export demand, but that soybean supplies for the crop year beginning October 1, 1953, are from 10% to 15% below the previous crop year. The formation of Staley International, Inc., a wholly owned subsidiary to handle distribution of company products in Western Hemisphere countries outside the U. S., was announced during 1953. The new corporation, according to Mr. Staley, will promote intensification of sales efforts in these trading areas.

◆ ◆ ◆

A new cellophane plant, to be located at Kern, Ind., has been announced by Mr. John M. Olin, president of Olin Industries, Inc. The projected plant is expected to double the company's present production of cellophane. According to Mr. Olin, "The substantial expansion of facilities for the production of Olin cellophane reflects the company's confidence in the continued growth of the transparent packaging industry. The consumer demand for more convenient, sanitary, transparent packaging has more than doubled the sales of cellophane during the past 10 years."

. . . *meeting hall and conference room*

To obtain an "on-the-spot" exchange of ideas on sales, technical service, development problems, and advancements on adhesives, resins, and starches, National Adhesives (Canada) Ltd., a subsidiary of National Starch Products, Inc., New York City, decided to hold its Annual Sales Conference in New York this year. Mr. Frank Greenwall, president of the parent company, outlined the progress of the 2 companies as well as future plans. Group discussions and an inspection tour of National's Alexander Research Laboratory in Plainfield, N. J., rounded out the 2-day program.

◆ ◆ ◆

Over 500 of America's leading wholesale druggists and executives of industries serviced by Magnus, Mabee & Reynard, Inc., attended the company's 14th Annual Dinner at the Waldorf-Astoria's Starlight Roof, New York City, March 6. Industrial, business, and professional leaders on the dais included E. E. Leuallen, dean of the College of Pharmacy, Columbia University; J. Wayne Luther, president, Druggists' Supply Corp.; Dr. John O'Neill Closs, executive vice president, American Pharmaceutical Manufacturers' Assn.; E. Allen Newcomb, executive secretary, National Wholesale Druggists' Assn.; Ray Schlotterer, executive secretary, Essential Oil Assn. of America; Percy C. Magnus, MM&R president, and vice presidents J. B. Magnus, R. B. Magnus, and G. H. McGlynn of MM&R. President Magnus pointed out that the dinner marked the firm's 60th year of business with world-wide activities, made possible in part by the confidence and friendship of the Wholesale Druggists of America.

◆ ◆ ◆

From the Flavoring Extract Manufacturers' Association comes news of their 45th Annual Convention, to be held in New York City at the Hotel Biltmore, May 16 to 19. Mr. Robert Krone of Fritzsche Bros., Inc., chairman of the Convention Committee, announces a partial roster of speakers, including: Mr. Louis Bohmrich, United Nations; Miss Bernice Connor, *Ladies' Home Journal;* Mr. Fred Bell, National Automobile Dealers Assn.; Mr. Robert C. Hibben, International Association of Ice Cream Manufacturers; Dr. John L. Barnhart, Dairy Industries Supply Assn.; Dr. Charles G. King, Nutrition Foundation; Dr. S. Sherwood, Sterwin Chemical Co.; Dr. Bernard L. Oser, Food Research Laboratories; and Mr. G. J. Williams, Dow Chemical Co. In addition, there will be addresses by members of the Vanilla Bean Assn., the Essential

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Oil Assn., and a report by Mr. Harold Janovsky, chairman of the FEMA Scientific Committee. An interesting entertainment program also is planned.

. . . *the human element*

Appointment of **Dr. Benjamin Borenstein** to the research staff of Fearn Foods, Inc., 9353 Belmont Ave., Franklin Park, Ill., was recently made known by Dr. Mois J. Sintov, director of research.

◆ ◆ ◆

FOR WORK WELL DONE—M. E. Powell (right), director of research, Knudsen Creamery Co., Los Angeles, accepts a certificate of appreciation for services rendered as retiring chairman, Southern California section, IFT. National president-elect Philip K. Bates (center), general manager of research, Carnation Co., Los Angeles, makes the presentation. Chairman-elect Max S. Dunn (left), Department of Chemistry, University of California at Los Angeles, adds his congratulations during the presentation at a recent meeting of the section.

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FOOD INDUSTRY TOPICS

(Continued from page 43)

Dr. Lawrence Atkin has been promoted to the post of assistant director of research at the Fleischmann Laboratories of Standard Brands, Inc. He will join

Mr. Robert F. Light in assisting Dr. W. R. Johnston, vice president and director of research, in supervising the research activities of the newly expanded laboratories at Stamford, Conn.

◆ ◆ ◆

Two new vice presidents and 2 new board members have been announced by Arthur D. Little, Inc., Cambridge, Mass. The new vice presidents are **Dr. Lawrence W. Bass** and **Mr. D. Reid Weedon. Mr. Stuart Hedden** of New Milford, Conn., and **Mr. Wm. Webster,** executive vice president, New England Electric System, were named directors. Mr. Earl P. Stevenson, company president, who made the announcements, also noted that the firm's new 70,000 square foot building in West Cambridge, Mass., was now occupied by the Research and Development Division—backbone of Little's activities.

◆ ◆ ◆

Dr. Lorraine S. Gall of National Dairy Research Laboratories, Inc., Oakdale, L. I., was recently awarded a Senior Research Fulbright Grant to study the role of rumen bacteria in ruminant metabolism at the Wallaceville Animal Research Station near Wellington, New Zealand. This research will be based upon techniques developed during her 10 years' experience in the field of rumen bacteriology.

◆ ◆ ◆

Mr. R. M. Hammes has been appointed assistant general sales manager in charge of the Niagara Filters Division and the Tolhurst Centrifugals Division of American Machine and Metals, Inc., East Moline, Ill. Mr. Hammes has been director of the firm's sales training program and assistant to the general sales manager in charge of sales promotion.

◆ ◆ ◆

Foster D. Snell, Inc., New York firm of consulting chemists, announces the return of **Mr. Marshall N. Levin** to the main office as editor of the company's *Chemical Market Abstracts.* Mr. Levin has been in Europe for the past two years as European correspondent for the journal.

EMPLOYMENT NOTICES

FOOD CHEMIST AND TECHNOLOGIST: Excellent opportunity in laboratory of Western New York State canning and freezing company. This position offers a real challenge to a man interested in making a career for himself in the food field. Prefer young man not over 30. Work to start June 1st when construction of new laboratory will be completed. **REPLY BOX** 326, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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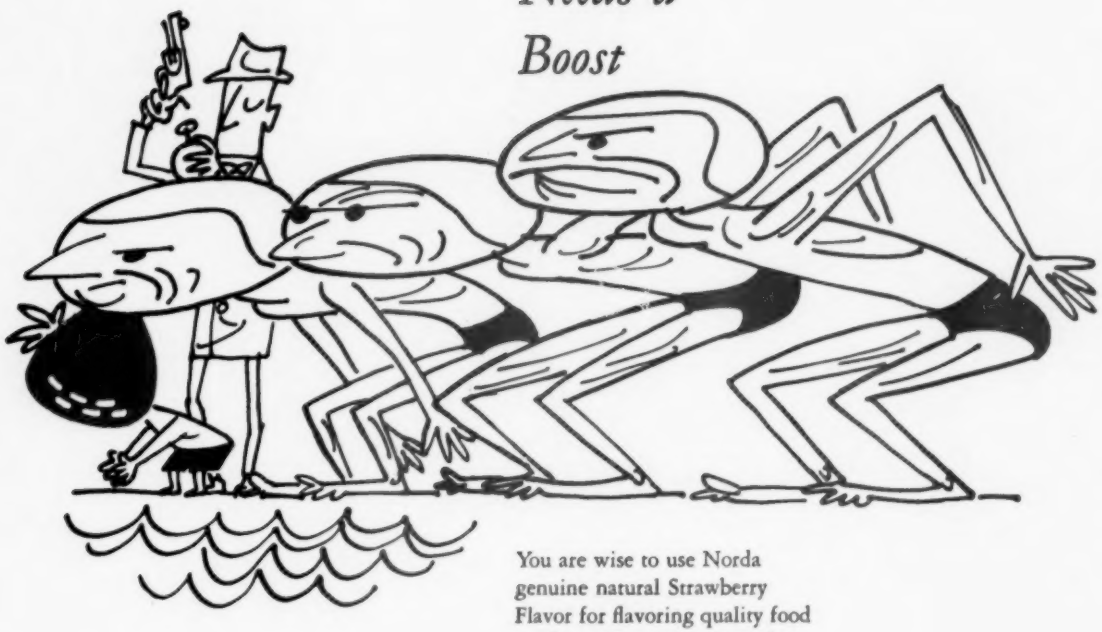

You are wise to use Norda genuine natural Strawberry Flavor for flavoring quality food products. They will always be uniformly fine, and they'll always be popular.

If it might increase your costs, and cut into your profits, to use only such a natural fruit flavor, consider supplementing it with Norda imitation Strawberry.

Norda imitation Strawberry Flavor is the perfect team-mate for the genuine article. Its characteristics are amazingly similar. It has the real fruit taste, its full-body, its concentrated strength and richness.

Try this profit-making combination. Test both of these outstanding Norda Strawberry Flavors by sending today for free samples.

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